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THE PL/OPA MULTICHANNEL TRANSMISSOMETER CONTROL AND DATA ACQUISITION SYSTEM

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FOR THE COMMANDER

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Optical Environment Division

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This Technical Report describes the control and data acquisition system developed for the GL/OPA visible and infrared multichannel transmissometer. The data logger and system calibration are described in detail. Transmissometer results from the July 1990 FLAPIR program are presented.

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1.0 Introduction

The Multichannel Transmissometer was designed and developed by AFGL (V. Turner) to provide both visible and IR path integrated transmissions for horizontal paths up to 2 km in length. Atmospheric transmission obtained as a function of wavelength may be utilized to verify transmission models such as Lowtran and investigate scaling relationships which allow prediction of transmission at wavelengths other than those which are routinely measured.

This report briefly describes the Multichannel Transmissometer (Section 2) and then describes its computer control an 'data acquisition system (Section 3) which is a modification of a general purpose Data Logger used on both the MOAL (Mobile Optical Atmospheric Laboratory) trailer and the RVAN (Radiometric Van). Calibration and data reduction are described in Section 4. Some representative data taken during field operations are contained in Section 5.

2.0 Transmissometer

The Multichannel Transmissometer is shown schematically in Figures 2.0-1 and 2.0-2. Measurements are made over the two-way path from transmitter/receiver to retro-reflector. A single reflective optics telescope with a baffle to divide it into two sections is used as both transmitter and receiver. A ribbon filament lamp (visible) and a 980 °C blackbody source (IR) each located one focal distance from the primary mirror are mechanically chopped (to provide differentiation between signal and ambient background in the received signal). Radiation from the two sources is combined by a 45° incidence Gold dichroic and relayed to the primary mirror by a 45° incidence SiO coated aluminum mirror. The collimated beam from the transmitter is then directed toward the retro-reflector telescope.

The retro-reflector is another simple reflective optics telescope with a plane SiO coated aluminum mirror at the focal position. A micrometer adjustment of the secondary mirror position allows focussing of the retro to provide maximum signal at the receiver for one way path lengths from 250 to 1000 meters. The optical configuration of the retro is tolerant of minor misalignment of the optical axes of the transmitter and the retro.

Light collected by the receiver telescope is directed toward the detectors by a 45° incidence SiO coated aluminum mirror and separated by dichroics and a plane mirror into visible, 3 - 5 μm, and 8 - 14 μm bands. One channel of the transmissometer monitors a narrow band visible wavelength (0.53 μm with an Si detector). A switching mirror and eyepiece with reticle provide a means of aiming the transmitter/receiver precisely at the retro.

Circular Variable Filters (CVF) in the optical path before each IR detector are used to resolve each IR band into 128 wavelengths with a bandpass approximately six percent of wavelength. The CVF filter occupies 180° of the filter wheel assembly - two fixed filter

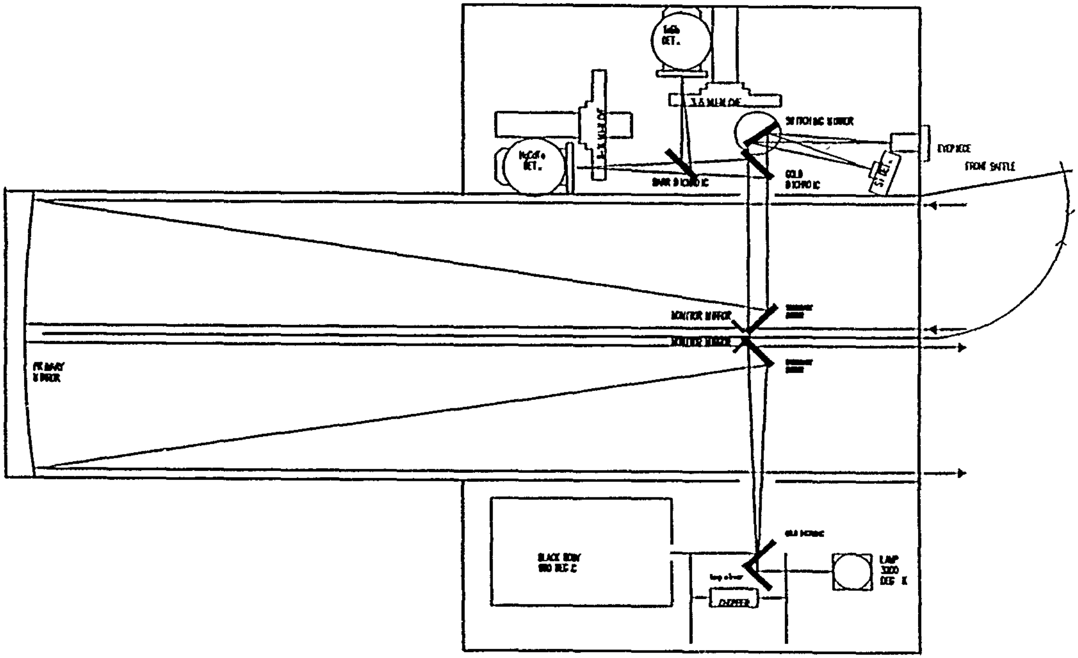


Figure 2.0-1. Diagram of the transmitter/receiver of the Multichannel Transmissometer.

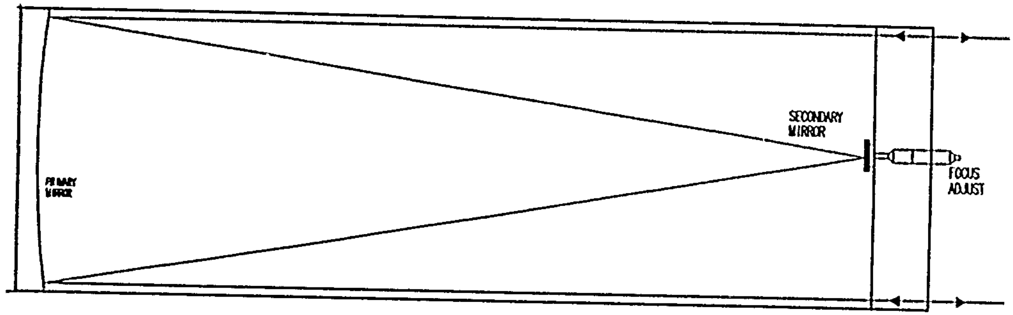


Figure 2.0-2. Retro-reflector telescope used with the Multichannel transmissometer.

positions have been installed in the remaining 180° segment of the filter wheel which may be fitted with narrow or broadband filters specific to any particular measurement program. The IR detectors are both LN_2 cooled - the 3 to 5 μm band uses an InSb detector and the 8 to 12 μm band uses an HgCdTe detector.

System stability is monitored (MONITOR MODE) by closing the front baffle of the receiver and opening a small aperture in the telescope divider baffle located between monitor mirrors 1 and 2 creating a short (4 meter long) beam path contained totally within the instrument. Data collected in MONITOR MODE is also used to determine the instrumental wavelength response needed to calibrate measurements taken over an atmospheric path (PATH MODE).

The Data Logger controls stepper motor drives to select CVF wavelengths to be measured, changes measurement mode (a motor drive actuates the front baffle and the calibration aperture) and sets measurement parameters of the EGG PARC Model 5209 Lockin Amplifiers which detect and amplify only that portion of the signal which is in phase with the optical chopping of the beam. The Logger samples and records the data after ensuring that amplifier output has settled.

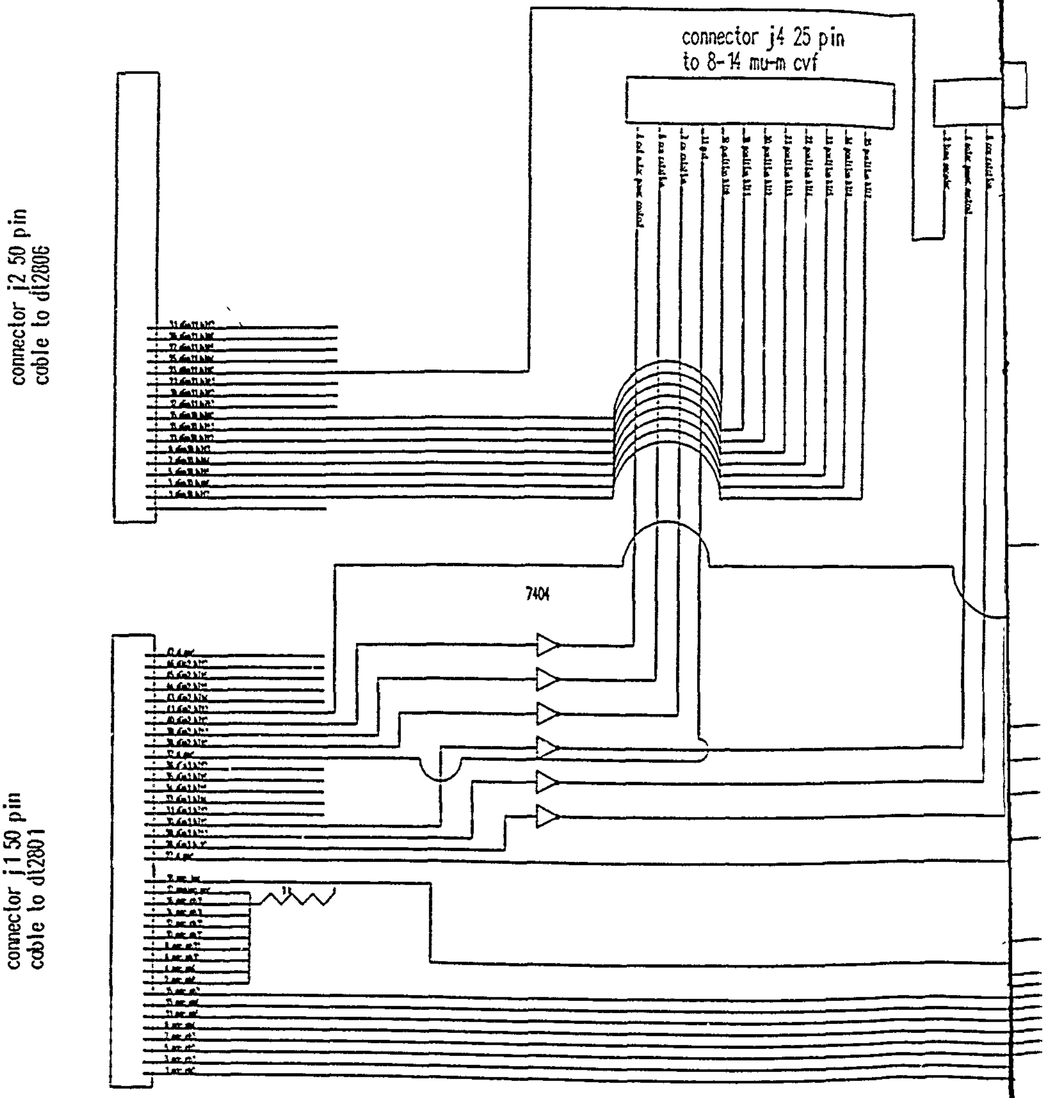
3.0 Data Logger

3.1 Interface to the Data Logger

Since the Multichannel Transmissometer was to operate as a stand alone instrument (independent of the MOAL Logger which has digital and analog patch panels sufficient for approximately 15 instruments) a simple connector box (Figure 3.1-1) was constructed to facilitate routing of the digital and analog signals to an AST-286 computer (an IBM PC-AT compatible) which executes the Data Logger program. Data Translation DT2801 and DT2806 cards in the computer provide 16 analog input channels and 2 bytes of digital I/O and 9 bytes of digital I/O respectively.

The output of the detector for each channel of the transmissometer is measured by an EGG PARC Model 5209 Lockin Amplifier. The outputs of the lockin amplifiers are connected to the computer's A/D converter through the interface box. Each channel had voltage dividers installed to protect the converter from overloading due to a high voltage output condition from the lockin amplifiers which occurs whenever the input stage of an amplifier is overloaded. A multi-port RS-232 serial communication card was added to the computer to allow setting and reading of the configuration of each of the three lockin amplifiers used to measure the detector outputs.

Digital data to control the CVF motors was buffered by the interface to achieve adequate voltage levels for the motor drivers. The wavelength at which each CVF is positioned


connector j4 25 pin
to 8-14 mu-m cvf
connector j2 50 pin
cable to dt2806
7404
connector j1 50 pin
cable to dt2801

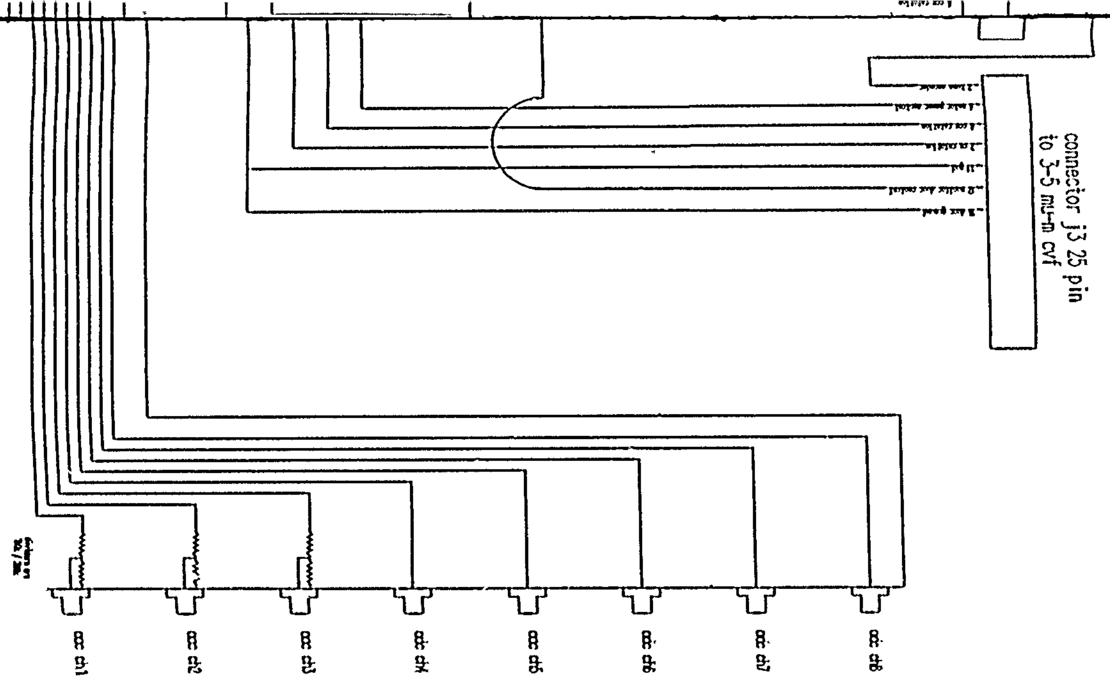


Figure 3.1-1. Schematic of connections from the Multichannel Transmissometer to the Data Logger.

is monitored either by a digital encoder or by a "home pulse" indicating a preset position of the filter wheel. Rapid operation of the CVF stepper motors was accomplished by increasing the drive voltage (from 8 to 22v). The Logger removes power from the motors whenever they are not in use to prevent damage from overheating. Measurement mode of the transmissometer is computer controlled with a digital signal to select internal "MONITOR" mode (a four meter path entirely within the instrument) or atmospheric "PATH" measurement mode.

3.2 General Description

The Data Logger is a general purpose data acquisition and control system based on an IBM compatible PC-AT computer with 16 channel A/D converter and varying amounts of digital I/O depending on the application. The Multichannel Transmissometer needed the addition of four RS-232 serial communication ports to control lockin amplifiers. The program is written in a structured high level pseudo-code basic (Better Basic) which executes much faster than interpretive basic, has true subroutine capability, assembly language interface and capability to use all of the first 640 k-bytes of computer memory. A simplified flow chart of the Logger program is contained in Appendix 1.

Logger functions are directed by "task files" (may be created with any text editor) which tell the computer how to control and sample data from any instrument. Execution of a task may be initiated or terminated at any time by the operator. Logger operation may also be altered during program execution through the use of function key routines. Operator comments may be entered at any time.

Data values recorded by the logger are fixed format packed data written in hexidecimal to conserve disk memory. Comment files are written in ASCII for clarity and instrument files (which contain a "history" of tasks executed, time and date executed and the instruments connected to the Logger at that time) are also written in ASCII. Details of all Logger files are also shown in Appendix 1.

Some unique features of the transmissometer required programming additional instrument specific routines. The primary purpose of these routines was to simplify the generation of task files. The large possible dynamic range of the signals and large changes from wavelength to wavelength also required that the details of the auto-ranging of the sensitivity of the lockin amplifiers be modified to ensure that whenever a change in sensitivity was made, a dwell time (or settling time) of at least three output time constants would elapse before recording the data.

4.0 System Calibration and Data Reduction

Voltages v_i output from the transmissometer measuring beam attenuation over an atmospheric path must be referenced to the expected voltage output v_e which would have been measured in the absence of an intervening atmosphere (and aerosols). Calibration is the process of determining v_e from measured and calculated parameters. Several assumptions must usually be invoked since it is unlikely that a zero extinction path will be available for the measurement of v_e. Once v_e is known, data reduction or finding the fractional transmission v_i/v_e for any given v_i is mechanically simple.

A number of definitions of parameters are needed for both calibration and data reduction and are summarized here instead of with the individual equations. Voltage refers to the voltage output of the transmissometer. Most variables are functions of wavelength (λ) which has been omitted for simplicity.

v_m is transmissometer monitor voltage (4 meter path)
v_{mc} is monitor voltage on the calibration day (4 meter path)
v_s is broadband filter voltage (4 meter path)
v_{sc} is broadband filter voltage on the calibration day (4 meter path)
v_p is transmissometer path voltage
v_{pc} is path voltage on the calibration day
m_o is the Lowtran model transmission for the 4 meter path with no atmospheric water content (calibration day)
m_w is the Lowtran model transmission for the 4 meter path with proper atmospheric water content (calibration day)
m_p is the Lowtran model transmission for the measurement path with proper atmospheric water content (calibration day)
m_{CO_2} is the CO_2 transmission on the calibration day (4 meter path)
t_{100} is the value of m_p at the wavelength chosen to have high transmission and be free of water and other absorption effects

4.1 Calibration

Calibration is performed by first operating the transmissometer in both monitor and path mode on a day when the air is sufficiently clear and dry that the extinction contribution due to aerosols can be considered negligible. Next, the atmospheric transmission model Lowtran is used to predict values of transmission for the monitor and path distances. A prediction for the monitor distance for zero atmospheric water content is also made (no aerosols are currently included in the predictions).

In general, transmission is calculated as below:

The calibration value (expected maximum path voltage) v_{pe} is

$$V_{pe} = V_{pc} \frac{m_o}{m_w}$$

where $\frac{m_o}{m_w}$ approximately corrects(increases) the calibration day path signal to a zero water content condition. Transmission for any other measurement is the ratio of measured to expected voltage corrected by the monitor voltage ratio (correction for possible system drift) times t_{100}. Note that t_{100} is a single point normalization of the transmissometer response to the Lowtran predicted transmission at a specific wavelength.

$$t = \frac{v_p/v_{pe}}{v_m/v_{mc}} t_{100}$$

4.1.1 Visible Channel

For the visible channel all model transmissions and voltage measurements are at 0.53 μm. v_{mc} and v_{pc} are taken as short time averages to reduce variability in the calibration. The expected path voltage is $v_{pe} = v_{pc}$. The correction for water vapor at 0.53 μm is always negligible and has been omitted.

4.1.2 3 to 5 Micrometer Band

For this IR channel (2.7 to 5.2 μm) the expected path voltage as a function of wavelength λ is

$$v_{\pi c}(\lambda) = \frac{v_{pc}(3.82)\, v_{mc}(\lambda) \dfrac{m_o(\lambda)}{m_\omega(\lambda)\, m_{XO_2}(\lambda)}}{\dfrac{v_{\mu X}(3.82)}{m_{XO_2}(3.82)}} .$$

Note that this channel has an additional correction for the large CO_2 absorption in the spectral range. This equation reduces to using the spectral shape of the clear day monitor scan normalized to the clear day path voltage at 3.82 μm (corrected for water and carbon dioxide absorption).

4.1.3 8 to 14 Micrometer Band

For this IR channel (7.2 to 13.1 μm) the expected path voltage as a function of wavelength λ is

$$v_{pe}(\lambda) = \frac{v_{pc}(11.03)\, v_{mc}(\lambda)\, \mathrm{sio}(\lambda) \dfrac{m_o(\lambda)}{m_\omega(\lambda)}}{v_{mc}(11.03)\, \mathrm{sio}(\lambda)} .$$

Due to low signal levels $v_{mc}(\lambda)$ is an average clear day monitor response normalized to the measured v_{mc} at 10.61 μm. sio (λ) is a correction for the difference in the number of 45 degree reflections from silicon monoxide coated aluminum mirrors (4 in monitor mode and 2 in path mode) whose reflectivity varies over this band. This reflectivity is shown in Figure 4.1.3-1.

4.1.4 Broadband

For the broadband filter positions the expected maximum path voltages v_{pe} are

(3-5 μm) $$v_{\pi c} = v_{\pi\chi} \frac{\int \dfrac{m_o(\lambda)}{m_{\chi O_2}(\lambda)}}{\int m_\omega(\lambda)}$$

and

(8-12 μm) $$v_{\pi c} = v_{\pi\chi} \frac{\int m_o(\lambda)}{\int m_\omega(\lambda)}$$

4.2.0 Data Reduction

Once the calibration constants have been determined transmissometer voltages may be converted to transmission using the following equations. The 0.53 μm transmission is

$$t = \frac{v_p/v_{pc}}{v_m/v_{mc}}$$

Transmission values in the 3 - 5 μm band are found from

$$t(\lambda) = \frac{v_p(\lambda)/v_{pe}(\lambda)}{v_\sigma/v_{\sigma\chi}}\, t_{100}(3.82)$$

where voltages v_s and v_{sc} for channel 2 (broadband filter output approximately 2.7 to 5.2 μm) are used to monitor the system stability because they are less susceptible to noise than

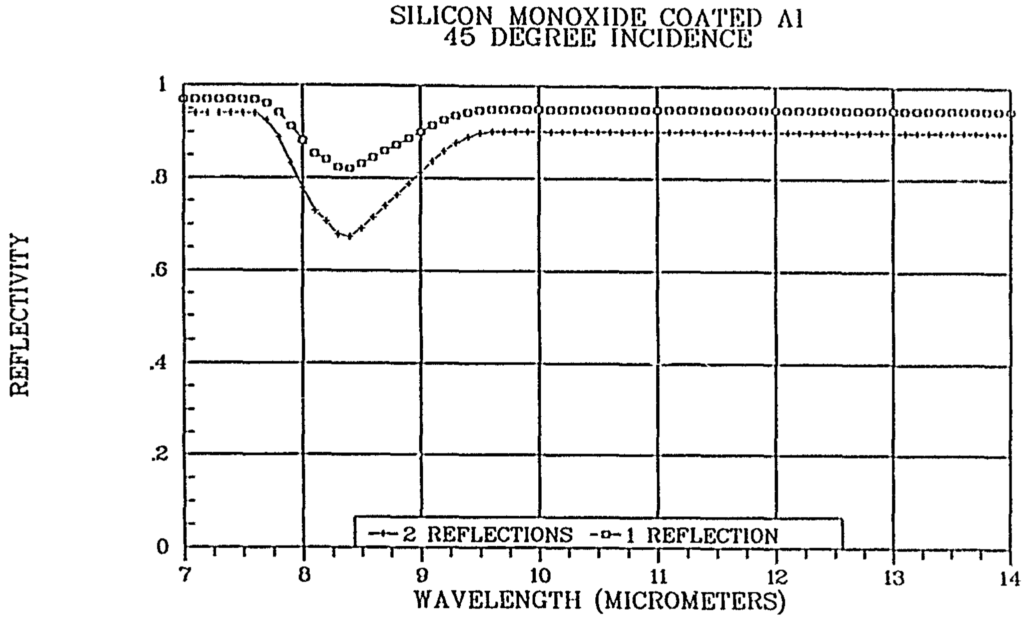


Figure 4.1.3-1. Spectral dependence of reflectivity at 45 degree incidence of an aluminum mirror coated with silicon monoxide.

monitor voltages at discrete wavelengths.

The 8 - 14 μm band transmissions are similarly calculated

$$t(\lambda) = \frac{v_p(\lambda)/v_{pe}(\lambda)}{v_\sigma/v_{\sigma\chi}} t_{100} \ (11.03)$$

where monitor voltages v_s and v_{sc} for channel 3 (broadband filter approximately 7.5 to 11.5 μm) are used to correct for system stability.

Broadband transmissions are calculated from

$$t_{100} = \frac{\int r(\lambda)\, f(\lambda)\, m_\pi(\lambda)}{\int r(\lambda)}$$

and

$$t = \frac{v_p/v_{\pi c}}{v_s/v_{\sigma\chi}} t_{100}$$

where r is the system response, f is the broadband filter transmission and the integrals are over the spectral extent of the filter.

5.0 Field Programs

The Multichannel Transmissometer was operated at the Geophysics Laboratory Sudbury Site at various times from August 1989 through May 1990 for purposes of test and alignment of the transmissometer, testing and modification of the Data Logger computer control and acquisition of data which was used to test and verify the method of calibration.

In July 1990 the system was used to measure transmission through various types of fog during the FLAPIR program which was primarily concerned with transmission at certain selected wavelengths (0.53, 1.06, 3.8, 10.6 μm, and broadband 3-5 and 8-12 μm). During 14 days of operation 73 hours of measurements were taken. Approximately 20 percent of the data was acquired for calibration purposes when the atmosphere was clear and relatively free of aerosols. The remainder of the data are representative of conditions ranging from light to heavy rain and light to heavy (extinctions to 50 inverse km at 0.89 μm) fog.

5.1 FLAPIR Results

The relative spectral response of the IR channels was calculated from the clear day monitor voltage v_{mc} using the CVF filters as monochrometers. CVF filter transmission and bandwidth were calibrated by the manufacturer. $v_{mc}(\lambda)$ was divided by the CVF throughput (bandwidth x transmission) to determine the unfiltered response of the system. Figures 5.1-1 - 2 show the CVF throughput for the two IR bands and Figures 5.1-3 -4 show the calculated unfiltered system response. For the 8-12 μm band there is a difference in response curves for monitor mode and path mode due to the number of silicon monoxide coated aluminum mirrors in the optical paths.

Broadband filter response was calculated simply as the product of unfiltered spectral response of the system and the transmission curve of the filter provided by the manufacturer. Transmission curves of the two broadband filters used during FLAPIR are shown in Figures 5.1-5 -6 and effective system response shown in Figures 5.1-7 -8. These filters were selected to closely approximate each of the bandpasses of the DUWIR, an imaging device viewing remotely placed blackbody sources in the 3-5 and 8-12 μm bands.

The calibration process (outlined in Section A.1.6 of Appendix 1) to determine expected maximum path voltages as a function of wavelength, maximum transmissions T_{100} and system monitor(stability) voltages was performed on data for two days judged to have the highest path transmission. These days were chosen on the basis of transmissometer voltage output and supporting measurements of extinction and particle counts from visibility meters (0.89 μm) and Particle Measurement Systems aerosol distrometers respectively. Atmospheric conditions measured by Naval Research Laboratory for the two calibration days (at the time of the calibration) are summarized in Table 5.1-1. Extinctions here were calculated based upon meteorological conditions and measured particulate size distributions.

DAY	TEMP. (°C)	PRES. (MB)	RH (%)	PART. (1/CC)	EXTINCTION (1/KM) 3.8 $\mu\mu$	10.6 $\mu\mu$
13	15.0	1022	73	230	0.002	0.001
14	17.2	1018	66	230	0.007	0.002

Table 5.1-1. Meteorological, particulate and point extinction data at the time of transmissometer calibration (provided by NRL).

Transmissometer voltages for each of the two days was then reduced to transmission using each of the calibrations and compared to the Lowtran predictions for the respective days Model transmission for the two bands for 13 July (smoothed to 8 percent of wavelength) are shown in Figures 5.1-9 -10. Measured transmission for the 13th (using the 13th as the calibration day - but omitting the data actually used to calibrate) is shown in Figures 5.1-11 - 12. Representative deviations of the measurements from the Lowtran model are in

Figures 5.1-13 -14 where the RMS deviation shown is over the band. A more comprehensive view of the deviations is contained in Table 5.1.-2 where several spectral scans were compared to one another (internal repeatability) and to the Lowtran model (external).

TRANSMISSOMETER PRECISION

INTERNAL (REPEATABILITY)

CAL DAY	DATA DAY	CHAN	RMS DEVIATION OVER BAND AND PATH 507 M	1039 M	1784 M
13	13	2	0.037	0.007	0.014
13	14	2	0.005	0.006	0.008
14	13	2	0.040	0.007	0.014
13	13	3	0.012	0.028	0.037
13	14	3	0.006	0.008	0.029
14	13	3	0.012	0.028	0.040

EXTERNAL (COMPARISON TO LOWTRAN)

EXTERNAL (COMPARISON TO LOWTRAN)

CAL DAY	DATA DAY	CHAN	RMS DEVIATION OVER BAND AND PATH 507 M	1039 M	1784 M
13	13	2	0.049	0.029	0.031
13	14	2	0.048	0.029	0.034
14	13	2	0.052	0.032	0.040
13	13	3	0.017	0.030	0.026
13	14	3	0.037	0.058	0.067
14	13	3	0.027	0.057	0.052

Table 5.1-2. Preliminary assessment of transmissometer precision and repeatability.

July 13th was considered to provide the best calibration and was then used to reduce all the remaining data. With the exception of 1.06 μm which was not covered by the Multichannel Transmissometer detectors measurements were made nearly continuously at wavelengths of interest. A small fraction of time was devoted to monitoring system stability and occasional full spectral scans were performed when the visibility appeared to be relatively stable. Some results are contained in Figures 5.1-15-19 which show transmissions during a radiative fog on July 2?. For comparison, Figure 5.1-20 show point measurements of extinction (0.89 μm) obtained with visibility meters (also operated by AFGL). Visibility meter one was located approximately 20 meters behind the transmissometer and visibility meter two was located downrange near retro-reflector two (approximately 521 meters).

Further analysis of the data is planned - specifically more detailed comparisons of measured transmission with the Lowtran model for model validation and an investigation of wavelength scaling dependencies. The task of evaluating communication, viewing or targeting system performance under various conditions is eased if transmission of the intervening atmosphere at the system operating wavelength may be accurately predicted from a transmission measurement at another routinely measured wavelength. Analysis of the scaling relationships may be carried out relatively easily for the three discrete wavelengths and broadband data mentioned above since nearly simultaneous measurements are available at all these wavelengths. Under clear conditions this is also true for any discrete wavelength in the IR bands covered.

Determination of scaling factors for all wavelengths in the IR bands during reduced visibility is slightly more difficult since full spectral scans of these bands with the CVF filters required about three minutes during which the visibility almost invariably changed. Thus comparisons will require interpolation or fitting of the transmission data to obtain time coincidence of the measurements.

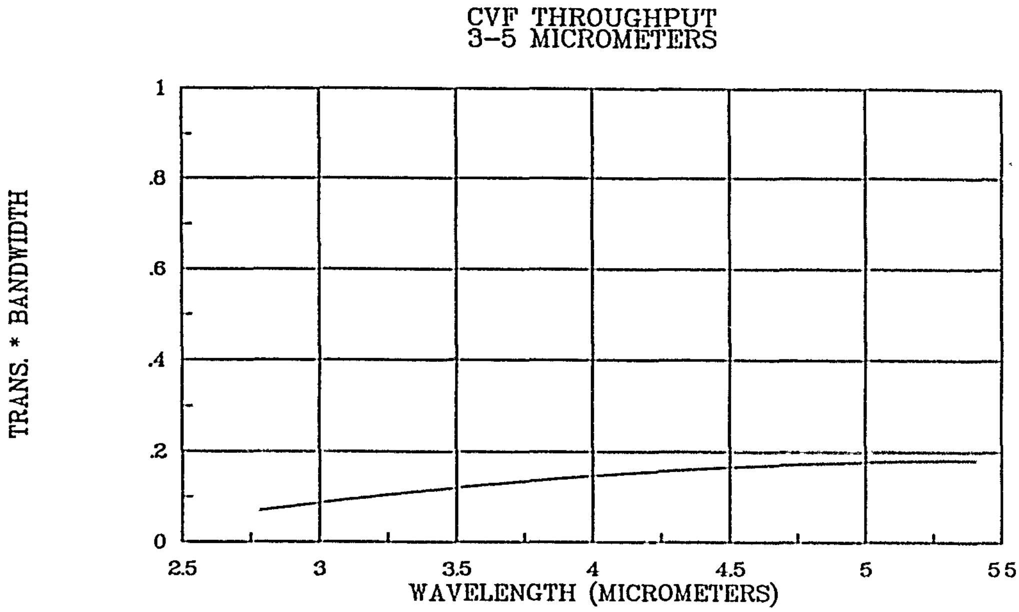


Figure 5.1-1. 3 to 5 micrometer band CVF throughput determined from the manufacturers data.

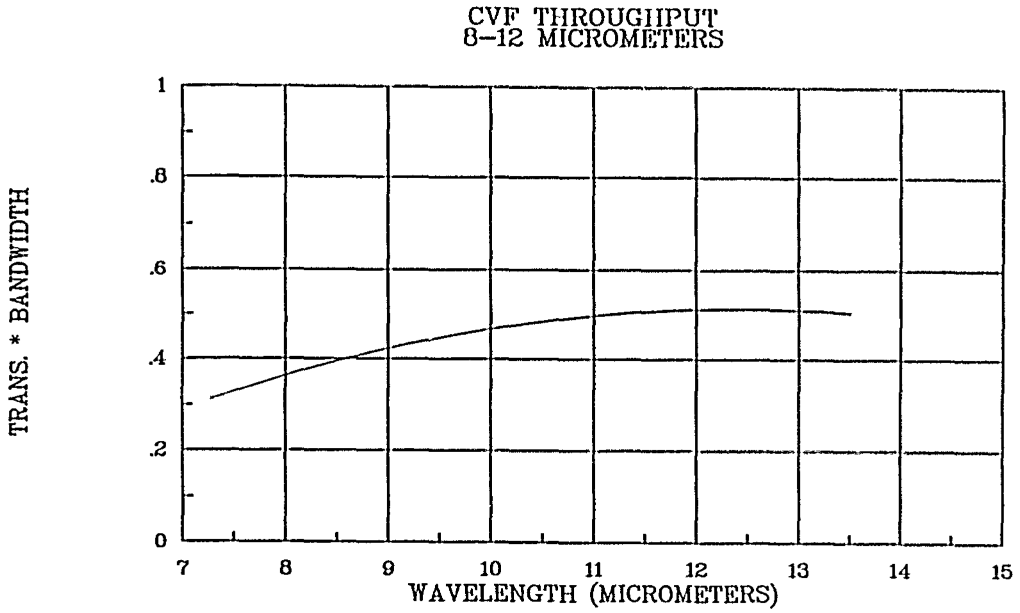


Figure 5.1-2. 8 to 12 micrometer band CVF throughput determined from the manufacturers data.

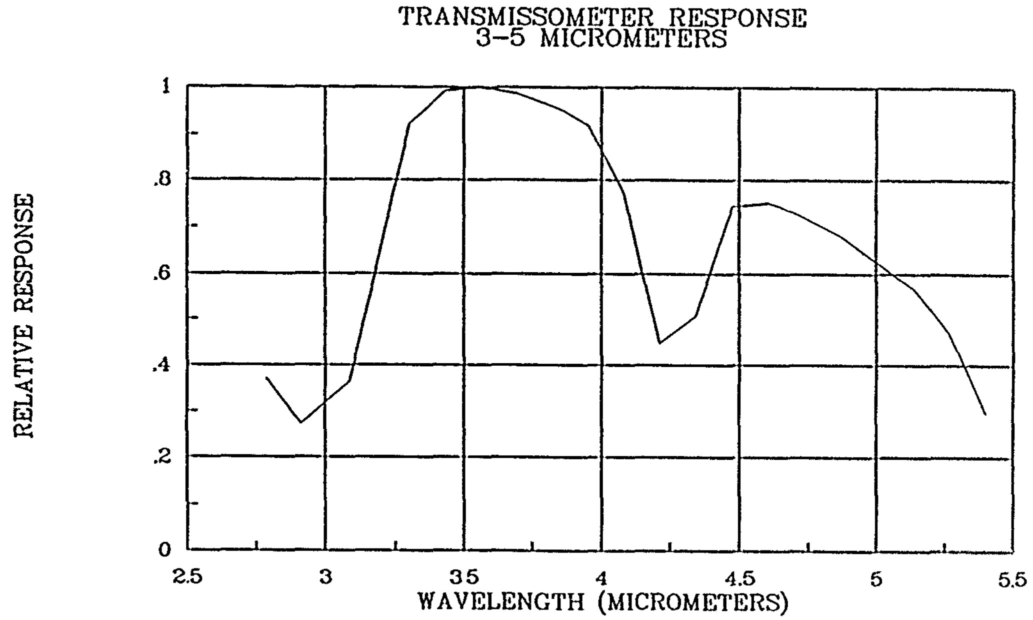


Figure 5.1-3. Unfiltered transmissometer response in the 3 to 5 micrometer band determined from monitor spectral scans and CVF throughput.

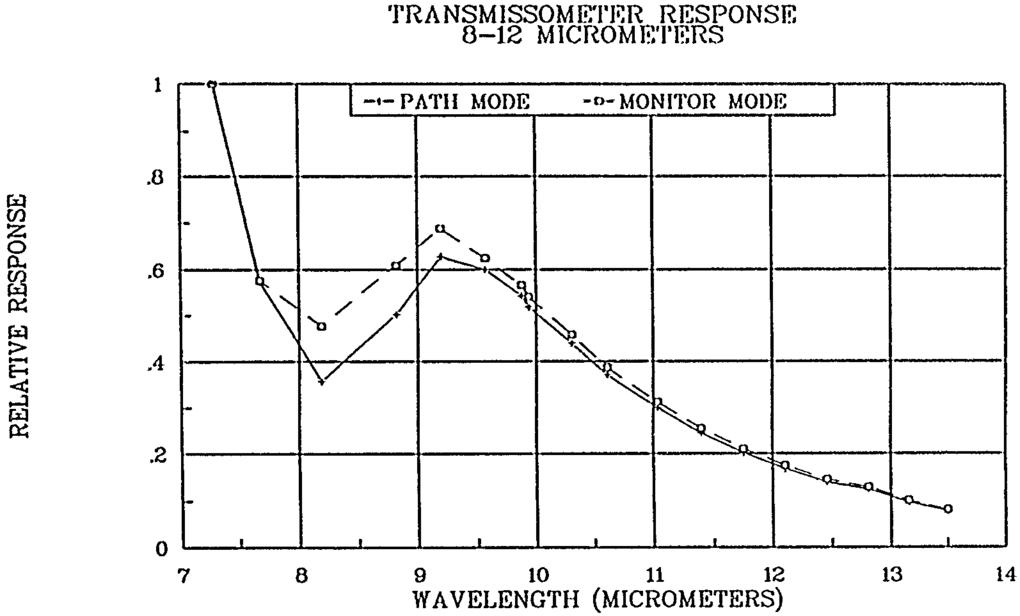


Figure 5.1-4. Unfiltered transmissometer response in the 8 to 12 micrometer band determined from monitor spectral scans and CVF throughput. Silicon monoxide reflectivities have been included.

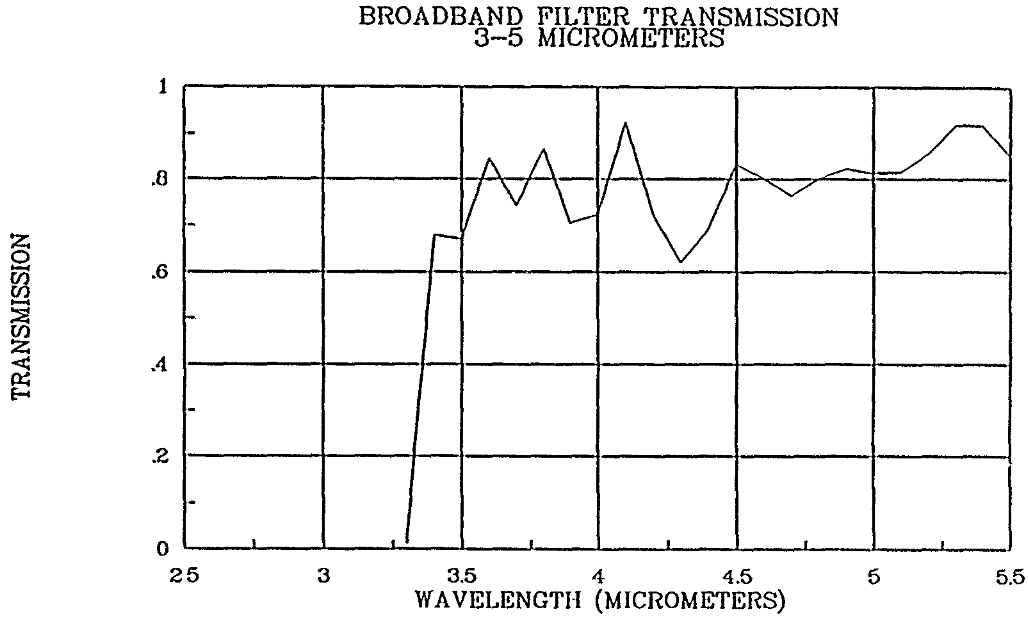


Figure 5.1-5. Manufacturers transmission data for the 3 to 5 micrometer broadband filter used for the FLAPIR program.

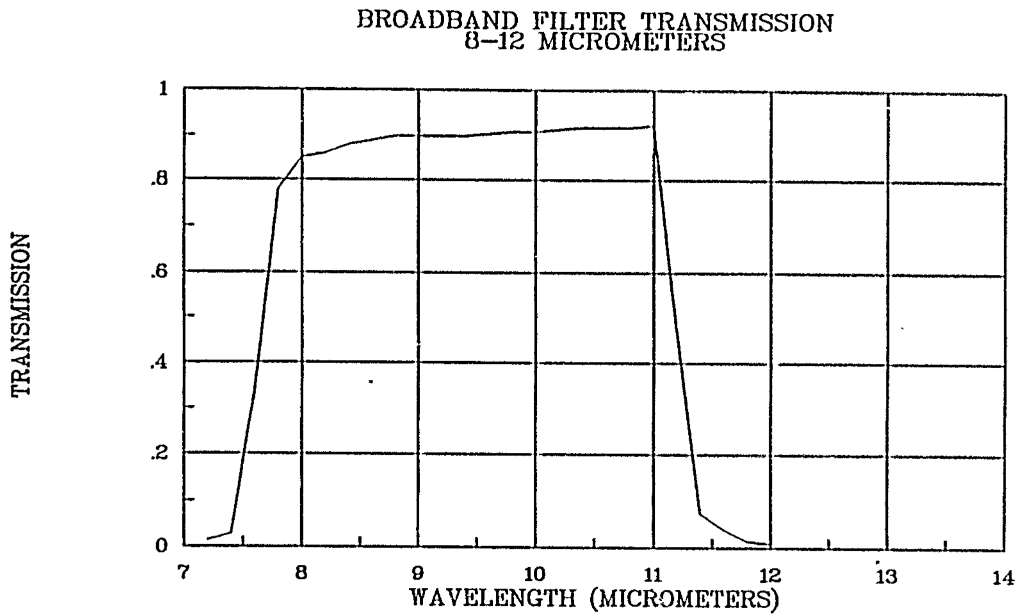


Figure 5.1-6. Manufacturers transmission data for the 8 to 12 micrometer broadband filter used for the FLAPIR program.

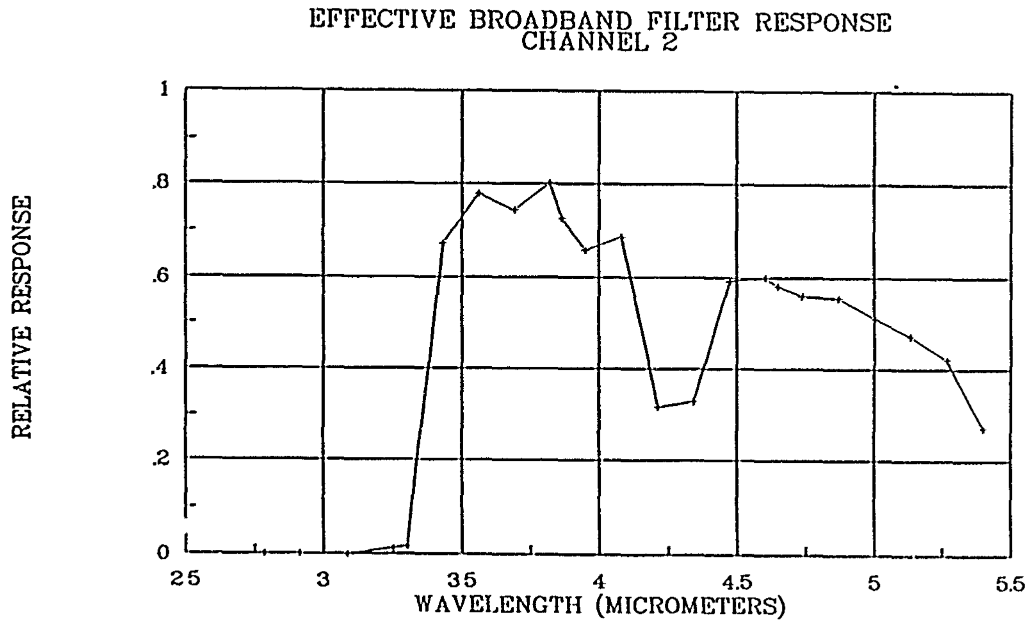


Figure 5.1-7. Effective transmissometer response with the 3 to 5 micrometer broadband filter (filter transmission times instrumental spectral response).

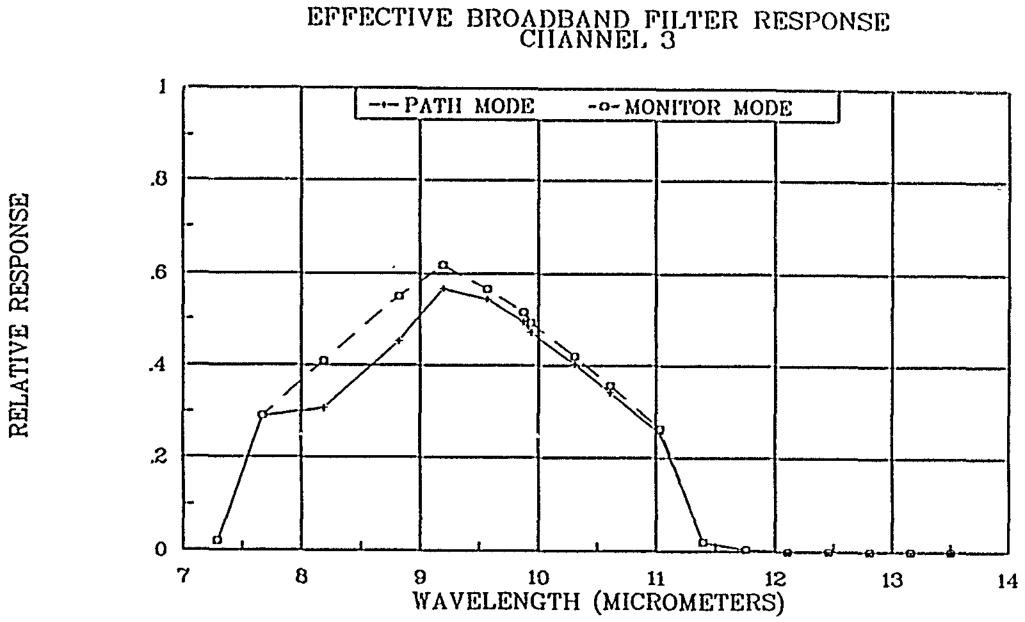


Figure 5.1-8. Effective transmissometer response with the 8 to 12 micrometer broadband filter (filter transmission times instrumental spectral response).

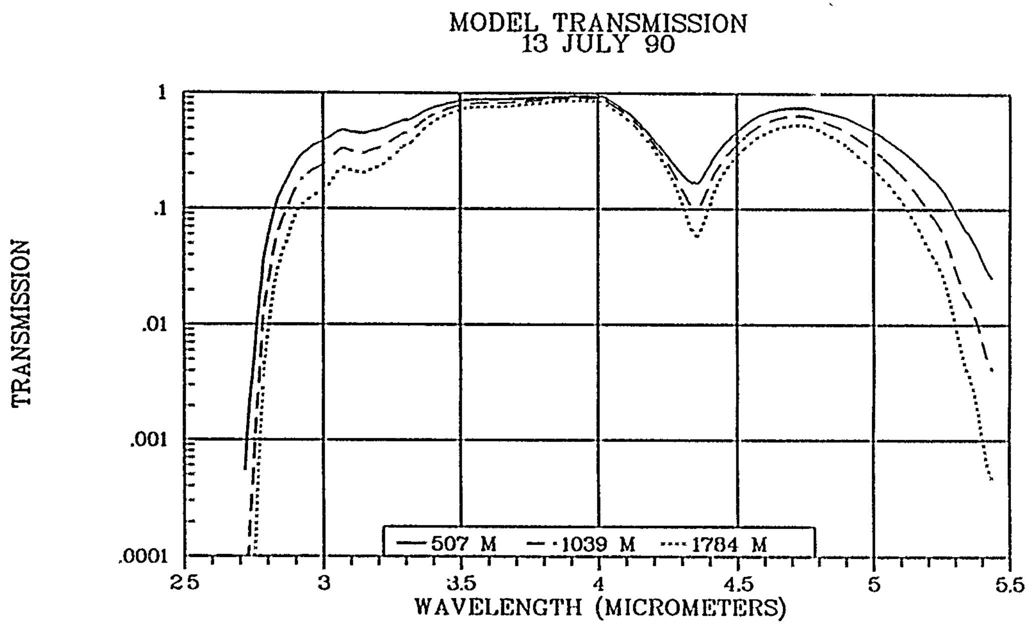


Figure 5.1-9. Lowtran transmission predictions for each of the three path lengths used on 13 July 90. Data have been smoothed to 8 percent of wavelength.

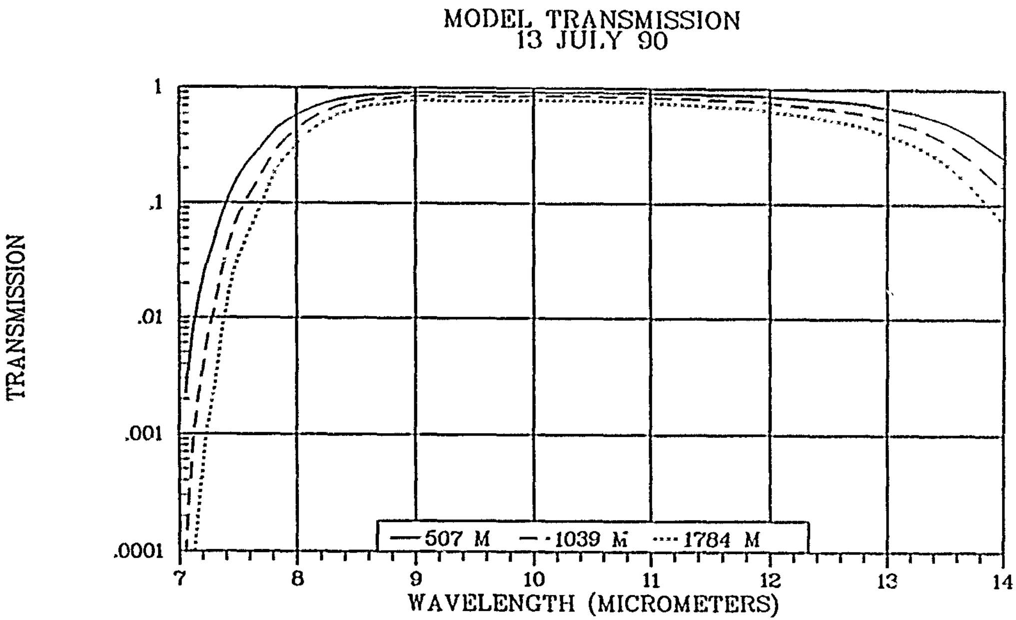


Figure 5.1-10. Lowtran transmission predictions for each of the three path lengths used on 13 July 90. Data have been smoothed to 8 percent of wavelength.

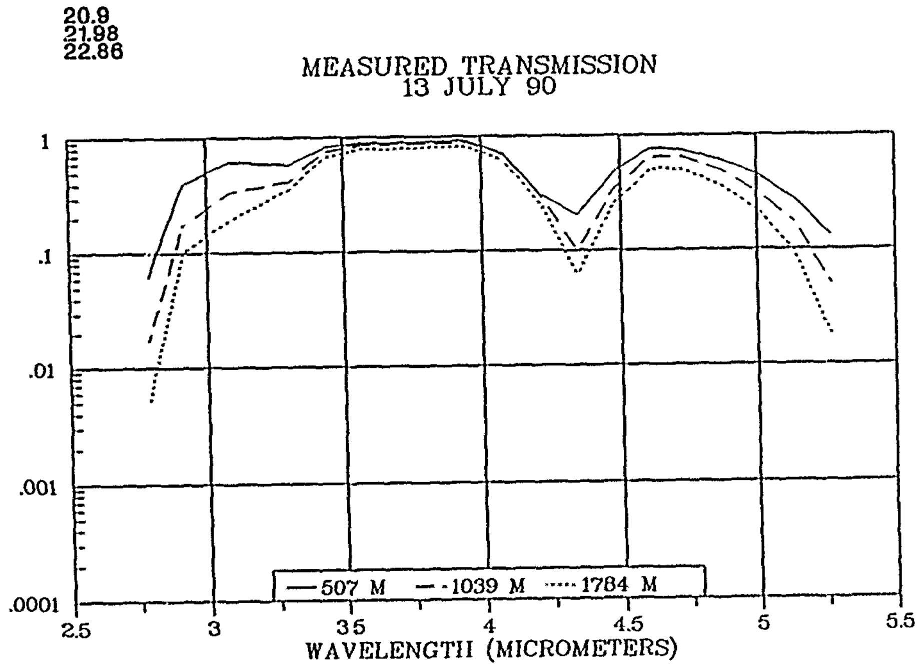


Figure 5.1-11. Transmission measurements taken on 13 July 90 for each of three path lengths.

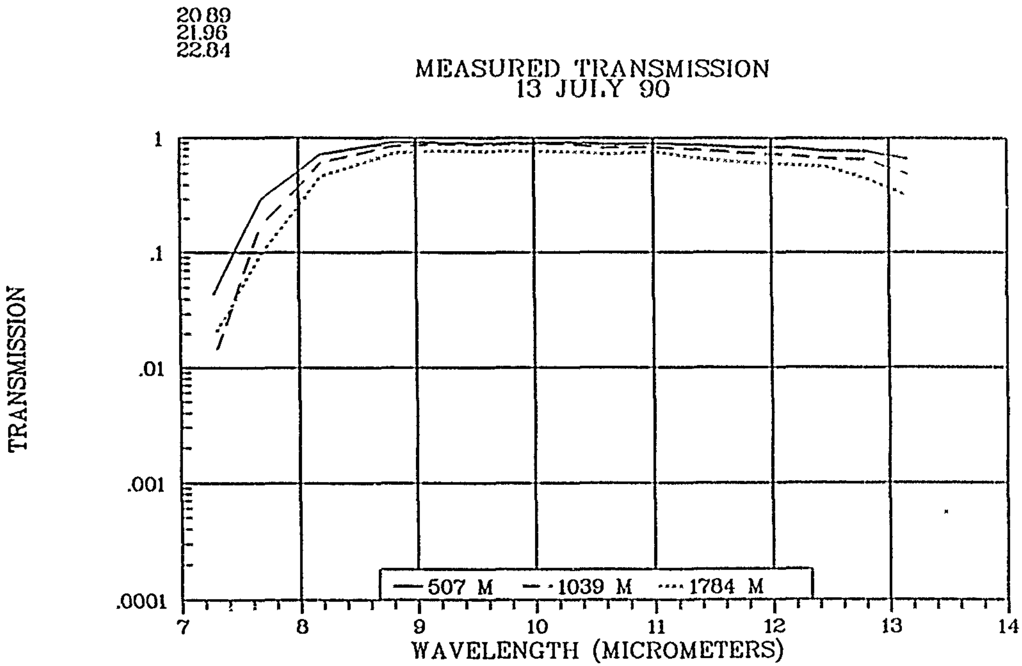


Figure 5.1-12. Transmission measurements taken on 13 July 90 for each of three path lengths.

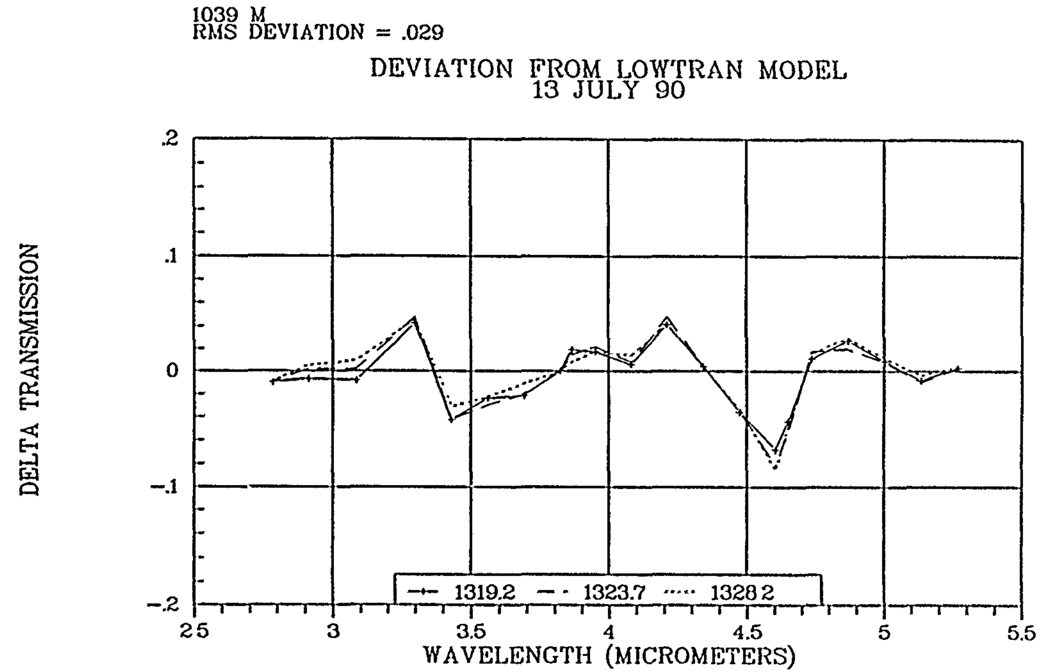


Figure 5.1-13. Representative deviation of measured 3 to 5 micrometer transmission from the Lowtran model on 13 July 90 for the 1039 meter path.

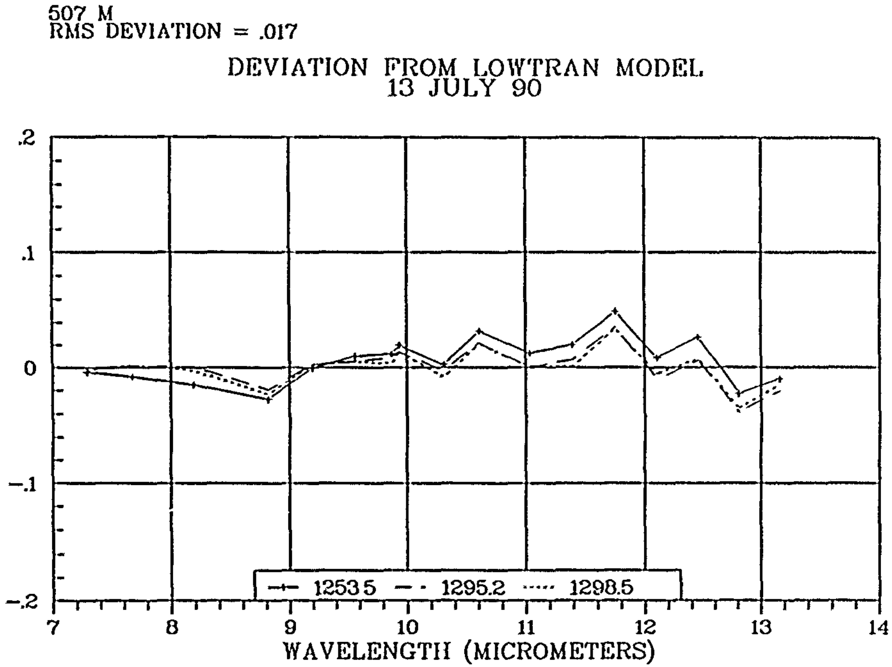


Figure 5.1-14. Representative deviation of measured 8 to 12 micrometer transmission from the Lowtran model on 13 July 90 for the 507 meter path.

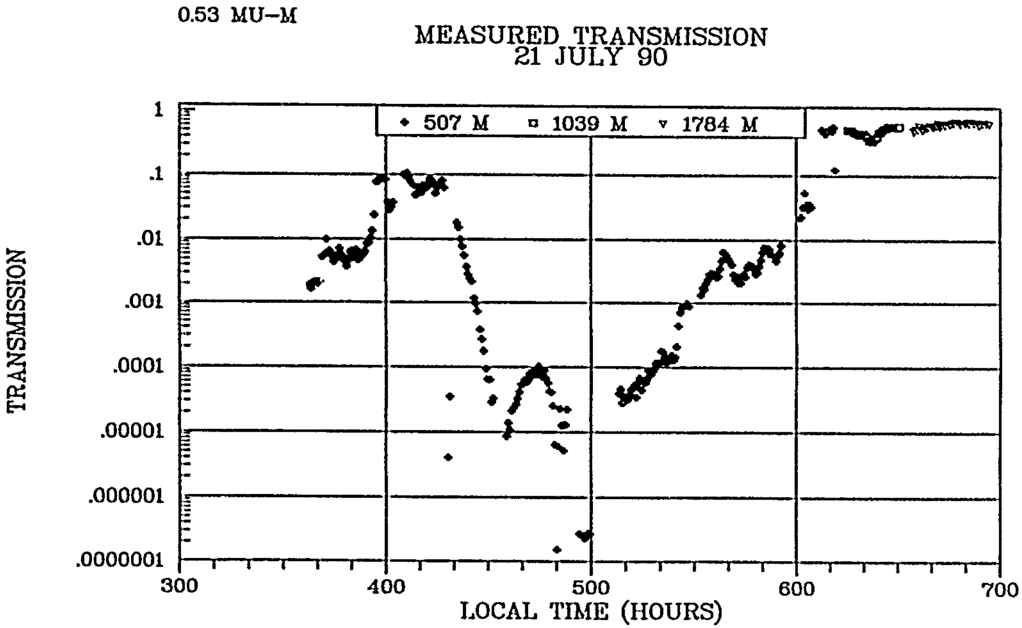


Figure 5.1-15. Transmission at 0.53 μm during the fog event on 21 July 90.

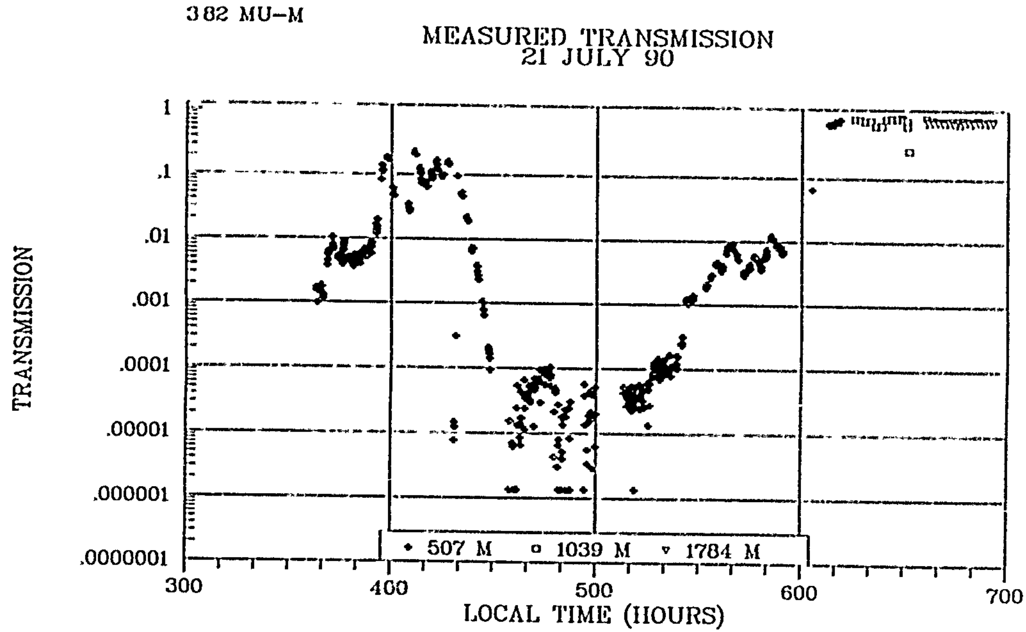


Figure 5.1-16. Transmission at 3.82 μm during the fog event on 21 July 90.

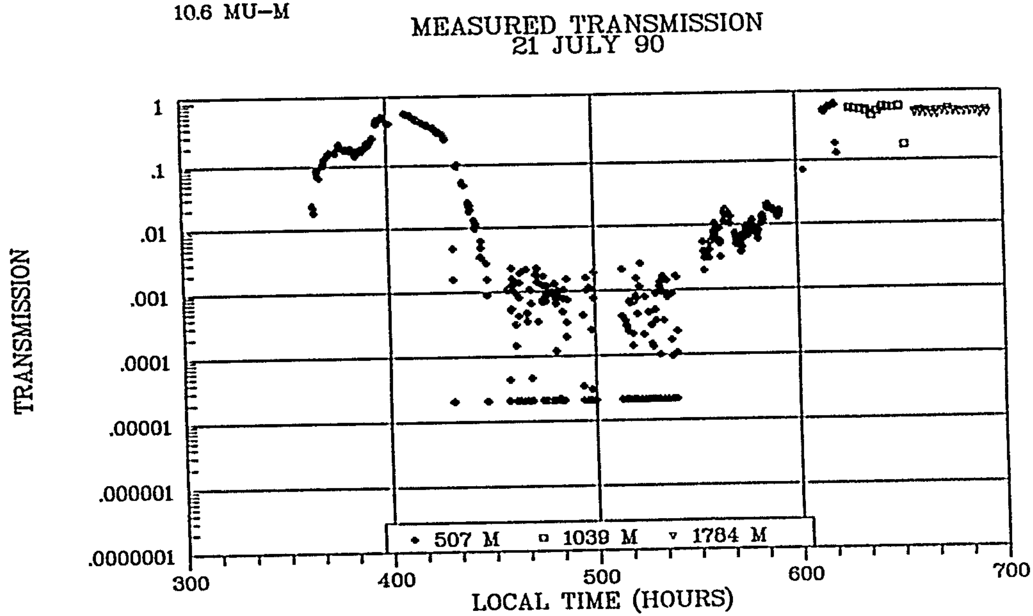


Figure 5.1-17. Transmission at 10.6 μm during the fog event on 21 July 90.

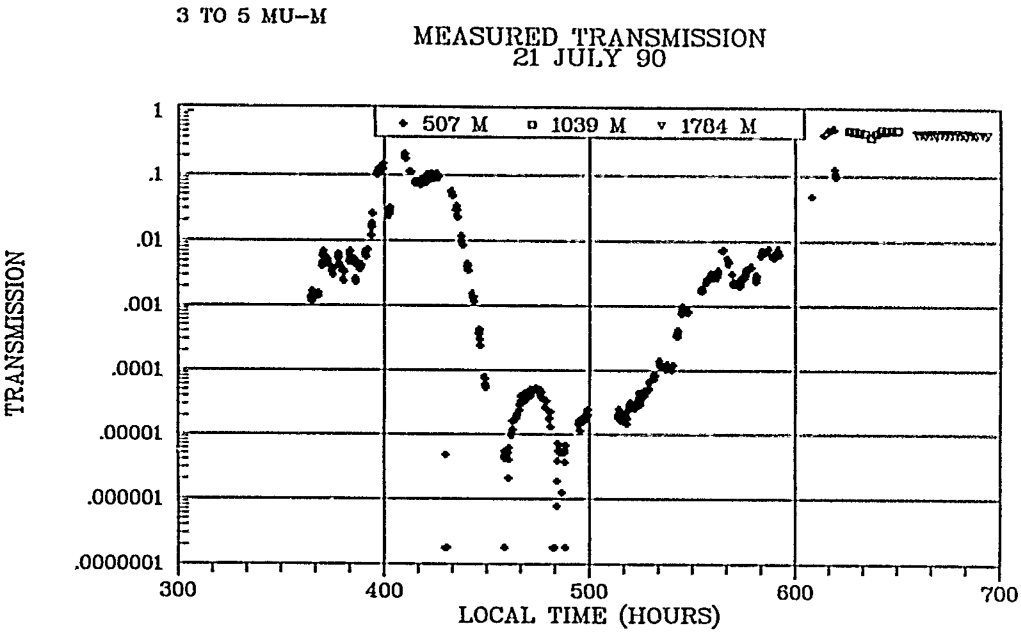


Figure 5.1-18. Transmission for the broadband 3-5 μm channel during the fog event on 21 July 90.

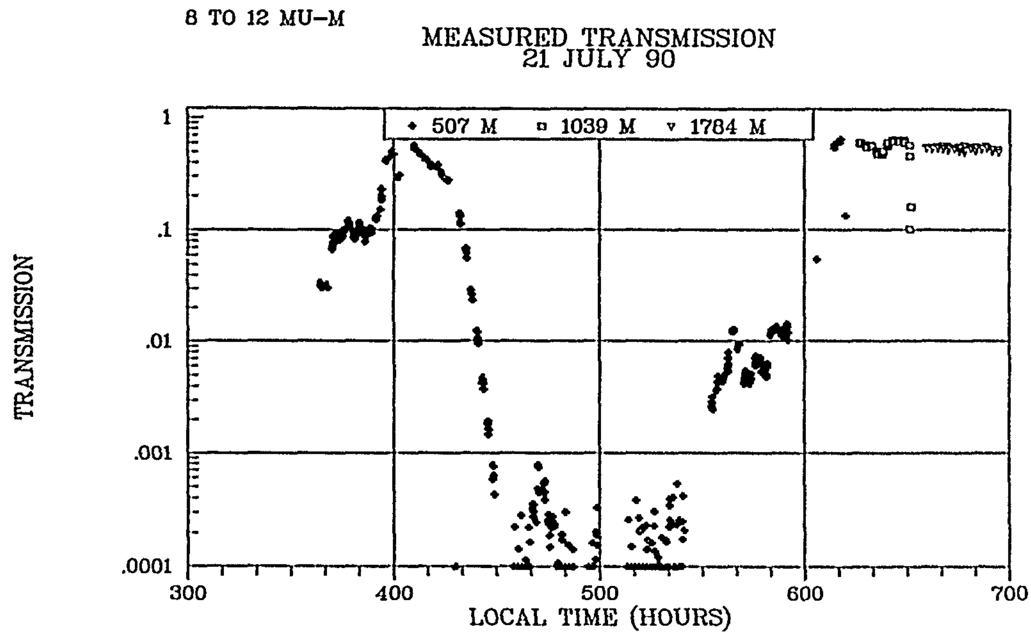
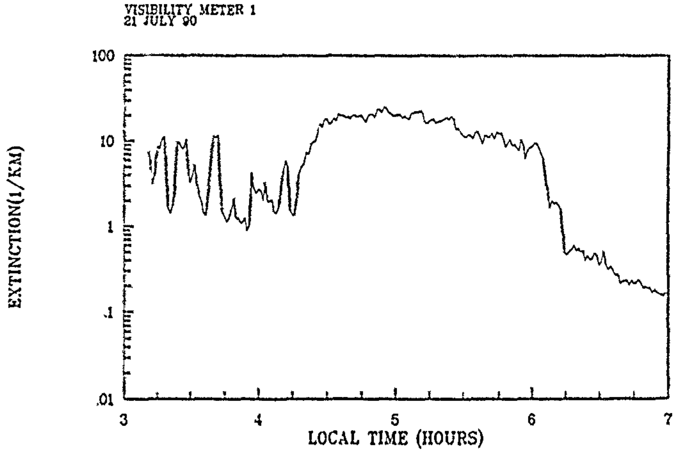


Figure 5.1-19. Transmission for the broadband 8-12 μm channel during the fog event on 21 July 90.



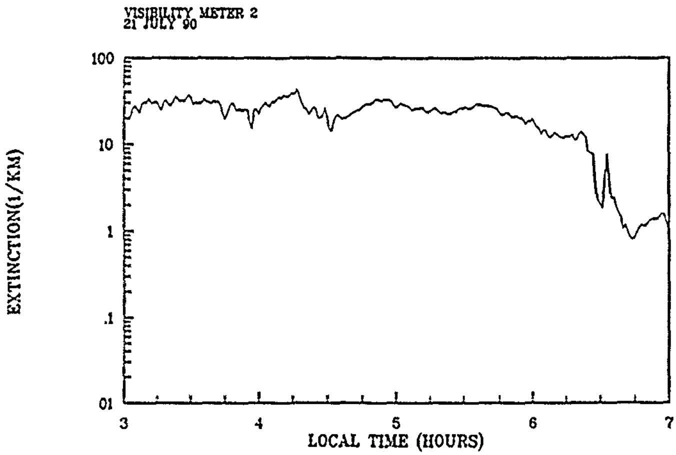


Figure 5.1-20. Extinction at 0.89 μm during the fog event on 21 July 90 measured with visibility meters.

APPENDIX 1
Data Logger and Data Reduction

A.1.1.0 Task files

Task files define for the logger what instruments are connected to the system, which hardware ports, A/D channels or serial channels they use, what control signals they require and how often to sample their output. Every task file begins with two lines which allow manual or automatic linking to the next task.

Header lines

LINE	CONTENT
1	LINK VERIFY - AT COMPLETION OF THIS TASK START THE TASK CONTAINED ON LINE 2. IF LINK VERIFY=0 NEXT TASK IS STARTED IMMEDIATELY. IF LINK VERIFY=1 OPERATOR MUST O.K. THE START OF NEXT TASK.
2	NEXT TASK AS "TASKFILENAME.EXT"

Header lines are followed by parameters for each instrument connected to the logger. The number of parameters required may vary depending upon the instrument.

Instrument definition lines

3-N INSTRUMENT PARAMETERS

The last line in the task file must always be an end of task marker line.

N+1 LAST LINE IS ALWAYS "END"

A.1.1.1 Instrument Parameter Definitions

Each of the instrument parameters is described below. Note that instrument codes (ICODE) in the task file must be sequential in ascending order. Except for instrument description and CVF position data (INAME$ AND ISTEPPOS) parameters are expected 10 per line in comma separated format. PAR is an abbreviation for a lockin amplifier. Bit mask values are for 8-bit digital I/O and should be entered as decimal. Parameters not needed for a particular instrument should usually be entered as a zero. Many parameters should always be entered as zero because they are determined as the Logger executes (these parameters have an asterisk after the NAME code below.

# NAME	DESCRIPTION
INAME$	SHORT DESCRIPTION OF INSTRUMENT (IN QUOTES)
1 ICODE	INSTRUMENT LOGGER CODE 1,2,3, ...
2 ISUBSW	SWITCH--SECONDARY INSTRUMENT--CAL/RUN CHANGES IGNORED
3 LOGNLOG	LOG DATA--1 DO NOT LOG--0
4 SERPORT	COM PORT NUMBER FOR SERIAL INSTRUMENT 1,2,3, ...
5 IDELT	INSTR. LOG DELTA TIME (SECONDS--2 SEC MINIMUM)
6 PARNPAR	INSTRUMENT USES PAR--1 NO PAR--0 SERIAL INSTR. --2 SERIAL PAR --3
7 PAUTOMAN	PAR IS IN AUTORANGE--1 MANUAL--0
8 PARAD	PAR A/D PORT ADDRESS (CONVERTER CHAN.)
9 PARDIO	PAR DIGITAL PORT ADDRESS
10 PARCURRVAL *	PAR CURRENT A/D VALUE SERIAL INSTR. MAX VALUE
11 PHITRIP	PAR AUTORANGE HIGH CHANGE VALUE(NORMALLY 80% FULL SCALE) OR FIRST PASS INDICATOR --SERIAL INST
12 PLOTRIP	PAR AUTORANGE LOW TRIP VVALUE(NORMALLY 25% FULL SCALE TRIP POINTS 87% AND 18% FOR RS232 PARS
13 PHICNT *	PAR NUMBER TIMES ABOVE TRIP POINT
14 PLOCNT *	PAR NUMBER TIMES BELOW TRIP POINT
15 PTRIPCNT	PAR MAXIMUM TIMES ALLOWED BEFORE RANGE CHANGE
16 PCURRRAN *	PAR CURRENT RANGE
17 PRUNRAN	PAR PRESET STARTING RANGE FOR ACQUIRE DATA
18 PCALRAN	PAR PRESET STARTING RANGE FOR CALIBRATION
19 PSCRENPL *	PROCESSED DATA FOR SCREEN PLOT
20 PHARDPL	PLOT TO CHART RECORDER 1 DON'T PLOT 0
21 POUTRAN *	PAR OUT OF RANGE--1 IN RANGE--0
22 PARDELT	DELTA T FOR PAR RANGE CHECK
23 PARTIMEC	RECOMMENDED PAR TIME CONSTANT (IDELT/3)
24 EXPANDED	50/80 PARAMETER DEFINITION - 0/1
25 ICALNCAL	PERFORM CALIBRATION--1 DO NOT--0
26 IRUNCAL *	RUN/CAL SWITCH 1-RUN 0-CAL
27 PARRANGED *	HALTS LOG TO DISK IF PAR CHANGED RANGE
28 ICONTPORT	DIGITAL NON-PAR CONTROL PORT ADDRESS RVAN-PORT FOR RADIOMETRIC INSTRUMENT START PULSES CVF CONTROL PORT
29 ICONMSKIN	BIT MASK FOR INPUT DATA
30 ICONMSKOUT	BIT MASK FOR OUTPUT DATA
31 ICONVAL	VALUE READ FROM CONTROL PORT
32 ICALT *	NOT USED
33 ICALDELT *	PAR - TIME FROM RANGE CHANGE TO BACK ON SCALE
34 IADPORT	NON-PAR A/D PORT ADDRESS
35 IADGAIN	A/D GAIN 1,2,4,8 (CODED VAL 0,1,2,3)
36 IADVAL *	VALUE READ FROM A/D PORT
37 IDIOPORT1	ADDRESS OF DIGITAL PORT 1
38 PORT1MSKIN	BIT MASK FOR INPUT
39 PORT1MSKOUT	BIT MASK FOR OUTPUT
40 PORT1VAL	VALUE READ FROM PORT 1
41 ISTEPNSTEP	STEPPING INSTR -- 1 NO STEP -- 0
42 FULLENCODE	1 CVF HAS ENCODER 0 CVF HAS HOME POSITION ONLY
43 ISTEPCOMP	SWITCH TO CHECK FOR STEP COMPLETE
44 IDIOPORT2	ADDRESS OF DIGITAL PORT 2
45 PORT2MSKIN	BIT MASK FOR INPUT

46 PORT2MSKOUT	BIT MASK FOR OUTPUT
47 PORT2VAL	VALUE READ FROM PORT 2
48 ICURRSTEP *	INDEX FOR STEPPER POSITION (1<=N<=40)(TABLE INDEX)
49 ECOND *	CVF HOME ERROR 0-NO ERROR 1-ERROR
50 NSTEPS	NO. OF STEP POSITIONS IN TABLE BELOW

Some instruments require an expansion of the instrument table to accommodate all of the parameters needed to define their operation. This expansion (parameter 24 - EXPANDED=1) is used for the Radiometric Van instruments, Multichannel Transmissometer and any instrument which uses a serial communication port to control lockin amplifiers.

51 REPEATCYC	RVAN-TASK REPEAT COUNT- N TIMES
	0 FOR CONTINUOUS
52 PRECEDENCE	RVAN-AZIMUTH/ELEVATION LOOPS
	0 ELEVATION FASTEST
	1 AZIMUTH FASTEST
53 STXM	RVAN- 1 SOLAR TRANSMISSOMETER
	0 OTHER RADIOMETRIC INST.
54 GRATELOCK	RVAN- 1 WAVELENGTH FIXED AT GRATEHOME
	0 INCREMENTS FROM GRATEHOME
	TO GRATEEND BY GRATEDEL
55 GRATEHOME	RVAN-STARTING WAVELENGTH (NM)
56 GRATEEND	RVAN-ENDING WAVELENGTH (NM)
57 GRATEDEL	RVAN-WAVELENGTH INCREMENT (NM)
58 AZIMLOCK	RVAN- 1 AZIMUTH FIXED AT AZIMHOME
	0 INCREMENTS FROM AZIMHOME
	TO AZIMEND BY AZIMDEL
59 AZIMHOME	RVAN-STARTING AZIMUTH (DEG)
60 AZIMEND	RVAN-ENDING AZIMUTH (DEG)
61 AZIMDEL	RVAN-AZIMUTH INCREMENT (DEG)
62 ELEVLOCK	RVAN- 1 ELEVATION FIXED AT ELEVHOME
	0 INCREMENTS FROM ELEVHOME
	TO ELEVEND BY ELEVDEL
63 ELEVHOME	RVAN-STARTING ELEVATION (DEG)
	MCTX - PATH 1, 2, OR 3
64 ELEVEND	RVAN-ENDING ELEVATION (DEG)
	PAR-RS232 BUFFER POINTER (PORTS3-6)
65 ELEVDEL	RVAN-ELEVATION INCREMENT (DEG)
	PAR-RS232 BUFFER POINTER (PORTS3-6)
66 GRATEINPORT	RVAN-WAVELENGTH INPUT PORT - DEFINES PORT N AND N+1
67 GRATEOUTPORT	RVAN-WAVELENGTH OUTPUT PORT - DEFINES PORT N AND N+1
68 RFILTINPORT	RVAN-FILTER INPUT PORT
69 RFILTOUTPORT	RVAN-FILTER OUTPUT PORT
70 AZIMINPORT	RVAN-AZIMUTH INPUT PORT - DEFINES PORT N AND N+1
71 AZIMOUTPORT	RVAN-AZIMUTH OUTPUT PORT - DEFINES PORT N AND N+1
72 ELEVINPORT	RVAN-ELEVATION INPUT PORT - DEFINES PORT N AND N+1
73 ELEVOUTPORT	RVAN-ELEVATION OUTPUT PORT - DEFINES PORT N AND N+1
74 DATAINPORT	RVAN-DATA INPUT PORT - DEFINES PORT N AND N+1
75 RANGEINPORT	RVAN-RANGE(EXPONENT) INPUT PORT

76 RIGHTASCINPORT	RVAN-RIGHT ASCENSION ERROR INPUT PORT	
77 DECLINERRPORT	RVAN-DECLINATION ERROR INPUT PORT	
78 TASKING	RVAN-	1 FOR RVAN RADIOMETRIC INSTRUMENTS 2 FOR CVF'S 0 FOR ANY OTHER INSTRUMENTS
79 SWITCH	RVAN - PLOT/DON'T PLOT CALIBRATION DATA - 1/0	
80 FILTOVRRIDE	RVAN - RADIOMETRIC FILTER SELECTION	0 AUTOMATIC FILTER AND GRATING (-1 THRU -4) SELECTED FILTER REMAINS BUT GRATING WILL AUTO CHANGE 6 AUTO FILTER, HIGH GRATE 7 AUTO FILTER, LOW GRATE

For the multichannel transmissometer the filter positions for measurement are entered one per line in position encoder format.

ISTEPPOS(I,J)	CVF FILTER POSITION FOR J= 1 TO NSTEPS (<=40) FOR TRANSMISSOMETRY FOR EACH J FOR THIS INSTRUMENT ENTER FILTER POSITION IN ASCENDING ORDER IN DECIMAL (0 TO 255 LEGAL). FIRST TABLE VALUE WILL BE USED FOR THE PRESET STARTING POSITION FOR THE FILTER. PRESET START SHOULD BE ZERO.

An alternate set of instrument parameter names is used when an RS-232 lockin amplifier is in use. These are used simply to make it easier to construct the task file.

52 TRACKING	RS232 PAR TUNING FILTER	0-MANUAL 1-TRACKING
53 DISPLAY1	RS232 PAR LEFT DISPLAY	0-REFERENCE PHASE 1-OSC. FREQUENCY 2-OSC. LEVEL 3-FILTER FREQUENCY 4-REFERENCE FREQUENCY
54 DISPLAY2	RS232 PAR RIGHT DISPLAY	0-% FULL SCALE 1-SIGNAL 2-% FULL SCALE OFFSET 3-% FULL SCALE NOISE 4-RATIO 5-LOG RATIO
55 DYN. RES.	RS232 PAR DYNAMIC RESERVE	0-HI STABILITY 1-NORMAL 2-HI RESERVE
56 EXPAND OUTPUT	RS232 PAR EXPAND	0-OFF 1-ON
57 OSC. F2F	RS232 PAR REFERENCE MODE	0-F MODE 1-2F MODE
58 SIG. FILTER	RS232 PAR SIGNAL FILTER	0-FLAT 1-NOTCH 2-LOW PASS 3-BAND PASS
59 REF. INT/EXT	RS232 PAR REF. SOURCE	0-EXTERNAL 1-INTERNAL

60 LINE FILTER	RS232 PAR LINE FILTER	0-OFF 1-2F(NOTCH AT 120HZ) 2-F(NOTCH AT 60HZ) 3-BOTH F AND 2F
61 TIME CONST.	RS232 PAR OUTPUT SMOOTH	0-1 MS 1-3 MS 2-10 MS 3-30 MS 4-100 MS 5-300 MS 6-1 S 7-3 S 8-10 S 9-30 S 10-100 S 11-300 S 12-1000 S 13-3000 S
62 SLOPE	RS232 PAR OUTPUT FILTER ROLLOFF RATE	 0-6db/OCTAVE 1-12db/OCTAVE
63 PATHINDX	MCTX - PATH 1, 2, OR 3	
64 COMOLD *	PAR-RS232 BUFFER POINTER (PORTS3-6)	
65 COMNEW *	PAR-RS232 BUFFER POINTER (PORTS3-6)	

A.1.1.2 Sample Task File

The following is an example of task file contents (MCSSCAL.CAL). This transmissometer task does a wavelength scan in monitor mode and then automatically links to another task (MCSRUN.CAL) to perform a wavelength scan in path mode.

For the Multichannel Transmissometer, task file names and instrument names follow a convention which is expected by the data reduction program (MCRED). Instrument NAMES are:

MCTX1 - visible channel
MCTX2 - 3-5 μm channel
MCTX3 - -14 μm channel.

All task file names must start with "MC". "MONITOR" (4 meters) task files must end with "CAL.CAL" and "PATH" task files must end with "RUN.CAL". The remaining three letters may be descriptive to the operator but have no significance to the data reduction program.

0	Automatic link to
'MCSRUN.CAL'	MCSRUN.CAL
'MCTX1'	
1,0,1,1,6,3,1,1,0,0	•
2850,590,0,0,2,0,11,12,0,0	•

```
0,2,0,1,1,0,0,2,0,0                 •
0,0,0,0,2,0,0,0,0,0                 •     Instrument 1 description
0,0,0,0,0,0,0,0,0,0                 •     visible channel
0,0,0,1,0,0,0,3,0,0                 •
6,1,3,0,0,0,0,0,0,0                 •
0,0,0,0,0,0,0,0,0,0                 •
"MCTX2"                             ]
2,0,1,3,6,3,1,2,0,0                 ]
2850,590,0,0,2,0,9,12,0,0           ]
0,2,0,1,1,0,0,2,0,0                 ]
0,0,0,0,2,0,0,4,1,0                 ]     Instrument 2 description
1,0,0,11,0,2,0,0,0,25               ]     3-5 μm channel
25,0,0,1,0,0,0,3,0,0                ]
6,1,3,0,0,0,0,0,0,0                 ]
0,0,0,0,0,0,0,2,0,0                 ]
0                                   •
6                                   •
12                                  •
18                                  •
24                                  •
30                                  •
36                                  •
40                                  •
42                                  •
48                                  •
54                                  •     Instrument 2 CVF positions
60                                  •
66                                  •
72                                  •
76                                  •
78                                  •
84                                  •
90                                  •
96                                  •
102                                 •
112                                 •
120                                 •
126                                 •
171                                 •
213                                 •
"MCTX3"                             ]
3,0,1,5,6,3,1,3,0,0                 ]
2850,590,0,0,2,0,6,12,0,0           ]
0,2,0,1,1,0,0,1,0,0                 ]     Instrument 3 description
0,0,0,0,2,0,0,4,1,0                 ]     8-12 μm channel
1,1,0,10,0,2,0,0,0,21               ]
21,0,0,1,0,0,0,3,0,0                ]
6,1,3,0,0,0,0,0,0,0                 ]
0,0,0,0,0,0,0,2,0,0                 ]
0                                   •
24                                  •
30                                  •
36                                  •
42                                  •
```

48	•	
54	•	Instrument 3 CVF positions
60	•	
66	•	
73	•	
78	•	
84	•	
85	•	
90	•	
96	•	
102	•	
112	•	
120	•	
126	•	
171	•	
213	•	
"END"	End of task file	

A.1.2.0 Data Files

The Logger creates three types of data files -

DATA FILE	- D+MONTH+DAY+HOUR.DLN
COMMENT FILE	- C+MONTH+DAY+HOUR.DLN
INSTRUMENT FILE	- I+MONTH+DAY+HOUR.DLN

where DLN is the logger number extension.

e.g. D051512.DL1 , C051512.DL1 , I051512.DL1 are files for 15 May for the hour 12 noon to 1 PM for data logger number 1.

Data files have a date/time line inserted in the file whenever the logger is started or restarted, at the start of each new hour and whenever a new task is started.

FORMAT : MONTH-DAY-YEAR-HOUR-MINUTE-SECOND-TASKBIT-TASKFILE
e.g. 05-15-90 12:30:21 1 C:\LOG\MCSSCAL.CAL

TASKBIT is 1 at logger start and at the start of any task -- it is 0 at the start of a new hour if the task commenced in the previous hour.

A.1.2.1 Data File Format

The basic format below is used for all instruments. Each line in the data file contains one logged value and status information for one instrument.

BYTE	BIT	CONTENT
1	7-4	MINUTE(TENS)
1	3-0	MINUTE(UNITS)
2	7-4	SECOND(TENS)
2	3-0	SECOND(UNITS)
3	7-0	INSTRUMENT CODE
4	7	PAR STATUS - CALIBRATE/RUN 1/0
4	6	PAR STATUS - AUTO/MANUAL 1/0
4	5	BAD DATA/GOOD DATA 1/0
4	4-0	PAR RANGE CODE ("00000" IF NOT A PAR)
5	7	DIGITAL/ANALOG INSTRUMENT 1/0
5	6	RADAR ON/OFF 1/0
5	5	LASER ON/OFF 1/0
5	4	RS232 PAR/OLD PAR 1/0
5	3-0	PAR TIME CONSTANT
6	7-0	FILTER CODE FOR CVF STEPPER(POSITION)
7	7-6	7-CVF PRESENT 6-CVF ERROR
7	5-4	GAIN CODE FOR A/D CONVERTER
7	3-0	LOGGED VALUE - HIGH ORDER
8	7-0	LOGGED VALUE - LOW ORDER

The format was modified for the PMS Rain Distrometer as shown below. A header entry precedes the data entries.

RAIN DISTROMETER HEADER

BYTE	BIT	CONTENT
1	7-4	MINUTE(TENS)
1	3-0	MINUTE(UNITS)
2	7-4	SECOND(TENS)
2	3-0	SECOND(UNITS)
3	7-0	INSTRUMENT CODE
4	7	HEADER LINE/DATA LINE 1/0
4	6	NOT USED
4	5	NOT USED
4	4-0	NOT USED
5	7-0	MINUTES - FROM DISTROMETER
6	7-0	SECONDS - FROM DISTROMETER
7	7-0	INTERVAL(SECONDS) - FROM DISTROMETER
8	7-0	INTERVAL(SECONDS) - FROM DISTROMETER

Data entries for the Rain Distrometer are only recorded when particle count for a particular size bin is non-zero.

RAIN DISTROMETER DATA LINE

BYTE	BIT	CONTENT	
1	7-4	MINUTE(TENS)	
1	3-0	MINUTE(UNITS)	
2	7-4	SECOND(TENS)	
2	3-0	SECOND(UNITS)	
3	7-0	INSTRUMENT CODE	
4	7	PAR STATUS - CALIBRATE/RUN 1/0	
4	6	PAR STATUS - AUTO/MANUAL	1/0
4	5	CAL/RUN MODE CHANGE IN PROGRESS 1/0	
4	4-0	PAR RANGE CODE ("00000" IF NOT A PAR)	
5	7	DIGITAL/ANALOG INSTRUMENT 1/0	
5	6	RADAR ON/OFF 1/0	
5	5	LASER ON/OFF 1/0	
5	4-3	NOT USED	
5	2-0	PAR TIME CONSTANT	
6	7-0	DISTROMETER BIN NUMBER	
7	7-0	PARTICLE COUNT - HIGH ORDER	
8	7-0	PARTICLE COUNT - LOW ORDER	

An expanded format was needed to accommodate the increased data which the RVAN radiometric instruments produce.

BYTE	BIT	CONTENT	
1	7-4	MINUTE(TENS)	
1	3-0	MINUTE(UNITS)	
2	7-4	SECOND(TENS)	
2	3-0	SECOND(UNITS)	
3	7-0	INSTRUMENT CODE	
4	7	DATA - OVERRANGE / OK	1/0
4	6	DATA OR RANGE BAD / OK	1/0
4	5	NOT USED	
4	4-0	NOT USED	
5	7-0	AZIMUTH (HIGH ORDER)	
6	7-0	AZIMUTH (LOW ORDER)	
7	7-0	ELEVATION (HIGH ORDER)	SIGNED
8	7-0	ELEVATION (LOW ORDER)	
9	7-0	RIGHT ASCENSION (HIGH ORDER)	SIGNED
10	7-0	RIGHT ASCENSION (LOW ORDER)	
11	7-0	DECLINATION (HIGH ORDER)	SIGNED
12	7-0	DECLINATION (LOW ORDER)	
13	7-0	WAVELENGTH (HIGH ORDER)	SIGNED
14	7-0	WAVELENGTH (LOW ORDER)	
15	7-0	FILTER (HIGH ORDER)	
16	7-0	FILTER (LOW ORDER)	
17	7-0	RANGE (HIGH ORDER)	
18	7-0	RANGE (LOW ORDER)	
19	7-0	DATA (HIGH ORDER)	SIGNED
20	7-0	DATA (LOW ORDER)	

A.1.2.2 Instrument File Format

The instrument file is updated under the same conditions as listed for the data file header line - start, restart, new hour and new task. this history of tasks executed is used during the data reduction process.

```
FORMAT :    DATE-TIME-LOGGER VERSION-TASKFILE
       :    INSTRUMENT NUMBER AND NAME
            .
            .
            .
       :    "END"
```

A SHORT EXAMPLE IS:

```
07-23-90        3:00:01 2.09 MCMDRUN.CAL
001MCTX1
002MCTX2
003MCTX3
END
07-23-90        3:24:24 2.09 MCMSCAL.CAL
001MCTX1
002MCTX2
003MCTX3
END
07-23-90        3:28:16 2.09 MCMRUN.CAL
001MCTX1
002MCTX2
003MCTX3
END
07-23-90        3:33:22 2.09 MCMDCAL.CAL
001MCTX1
002MCTX2
003MCTX3
END
07-23-90        3:35:18 2.09 MCMDRUN.CAL
001MCTX1
002MCTX2
003MCTX3
END
```

A.1.2.3 Comment File Format

Operator entered comments are recorded along with the time of entry. Descriptions of atmospheric conditions, operation mode or problems with operation are very valuable during subsequent data analysis. A maximum of 80 characters may be entered in a single comment.

Example comment file:

```
0723 3:15:58 MEDIUM PATH
0723 3:24:43 VERY LIGHT RAIN NOW
0723 3:25:04 AND LIGHT FOG
0723 3:55:19 PATCHY FOG
0723 3:57:43 MOVING TO SHORT PATH
```

A.1.3.0 Function Key Assignments

Certain operations or changes in logging procedure or parameters may be accomplished while the program continues to acquire data. Some function keys not listed here may be active, but their use could produce unpredictable results since they are used primarily as debugging tools.

KEY	ACTION
F1	TOGGLE DATA LOGGER ON/OFF L 1/0 1 - NORMAL CONTROL AND LOGGING 0 - STOPS ALL LOG AND CONTROL FUNCTIONS
F2	TOGGLE PRINT LOG ON/OFF PL 1/0 DEBUG - 1 PRINT LOGGED DATA
F3	TOGGLE SCREEN PLOT ON/OFF SP 1/0 1 - PLOT DATA ON SCREEN 0 - DON'T PLOT DATA ON SCREEN
F6	DISPLAY THE INSTRUMENT DESCRIPTION VALUES FOR A PARTICULAR INSTRUMENT. PRIMARILY DEBUG.
F8	SHOW INST. CODES OF LOGGED INSTRUMENTS
F9	QUIT THE LOGGER
F10	ALTER THE DIGITAL SCREEN DISPLAY. CHANGE THE INSTRUMENTS DISPLAYED ON THE SCREEN
UP-ARROW	ALTER THE SCREEN PLOT DISPLAY. CHANGE THE INSTRUMENTS PLOTTED ON THE SCREEN.
DOWN ARROW	ENTER LOGGER COMMENT

THE FOLLOWING FUNCTION KEYS MUST HAVE CAPS-LOCK ON

ALT-CTRL-F2	TOGGLE DATA LOGGING ON/OFF NL 0/1 0 - DATA LOGGED TO DISK 1 - INSTRUMENTS ARE CONTROLLED BUT NO DATA IS LOGGED.
ALT-CTRL-F3	ISSUE NEW TASK TO THE LOGGER ENTER TASK FILE NAME WITH EXTENSION.
ALT-CTRL-F4	GENERATE MAP OF I/O PORT USE. DEBUG.

ALT-CTRL-F6	GENERATE A TASK FILE (RVAN ONLY). LOGGING IS TERMINATED TO EXECUTE THIS ROUTINE.
ALT-CTRL-F7	SWITCH TO FAST LOGGING (2 SECOND INTERVAL) USED TO LOG THE NEPHELOMETER CALIBRATION ENTER TASKFILE NAME = NEPH.CAL .
ALT-CTRL-F8	SWITCH BACK TO NORMAL LOGGING (5 SECOND INTERVAL) THIS IS A RETURN FROM FAST LOGGING. ENTER TASKFILE NAME
ALT-CTRL-F9	PRINT A FILE (PRIMARILY TO ACCESS OLD COMMENT FILES). LIMITED TO FILES IN D:\LOG\DATA .

A.1.4.0 Logger Operation

General operation instructions are on the left while some specifics for the Multichannel Transmissometer are on the right.

TURN ON COMPUTER AND ALL ATTACHED EQUIPMENT.	SET CVF MOTOR VOLTAGE TO 22 VOLTS.
SCREEN PROMPT SHOULD BE D:\ OR D:\LOG\	SET CVF'S TO COMPUTER CONTROL. SET MONITOR DOOR(FRONT BAFFLE)
-BE SURE THAT [CAPS LOCK] IS ON-	CONTROL TO AUTOMATIC.
TYPE HARDLOG [RET]	
LOGGER PROGRAM WILL START AND ASK FOR TASK NAME.	
ACCEPT THE DEFAULT TASK OR ENTER A NEW TASK.	
FOLLOW PROMPTS AND USE FUNCTION KEYS AS REQUIRED.	
IF LOGGER WON'T RESPOND TO ENTRIES YOU CAN ABORT BY TYPING CTRL-BREAK.	THIS MAY LEAVE THE POWER ON THE CVF MOTORS. POWER <u>MUST</u> BE TURNED OFF TO PREVENT DAMAGE. TYPE QUIT [RET]
TO RESTART LOGGER FROM WITHIN BASIC HIT FUNCTION KEY F2.	
TO STOP LOGGER HIT FUNCTION KEY F9. PROGRAM WILL ASK FOR CONFIRMATION BEFORE STOPPING.	
TO EXIT FROM BASIC TYPE BYE [RET]	

Below is a sample complement of transmissometer task files (as used during the FLAPIR program):

FILE	ACTION	PATH
MCSET.DWL	Setup and zero the CVF'S	internal
MCSSCAL.CAL	Single monitor scan	internal
MCSRUN.CAL	Single path scan	3
MCSFCAL.CAL	Single monitor scan	internal
MCSFRUN.CAL	Five path scans	3
MCMSCAL.CAL	Single monitor scan	internal
MCMRUN.CAL	Single path scan	2
MCMFCAL.CAL	Single monitor scan	internal
MCMFRUN.CAL	Five path scans	2
MCLSCAL.CAL	Single monitor scan	internal
MCLRUN.CAL	Single path scan	1
MCLFCAL.CAL	Single monitor scan	internal
MCLFRUN.CAL	Five path scans	1
MCSDCAL.CAL	Short monitor scan (selected wavelengths)	internal
MCSDRUN.CAL	Path scans (selected wavelengths)	3
MCMDCAL.CAL	Short monitor scan (selected wavelengths)	internal
MCMDRUN.CAL	Path scans (selected wavelengths)	2
MCLDCAL.CAL	Short monitor scan (selected wavelengths)	internal
MCLDRUN.CAL	Path scans (selected wavelengths)	1

A.1.5.0 Simplified Logger Flow Diagram

TRANSMISSOMETER DATA LOGGER
FLOWCHART

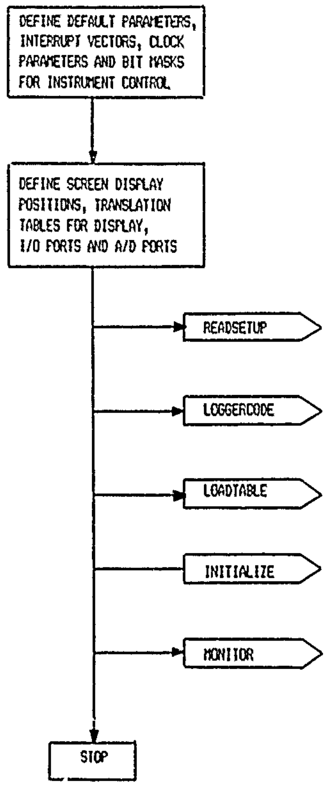
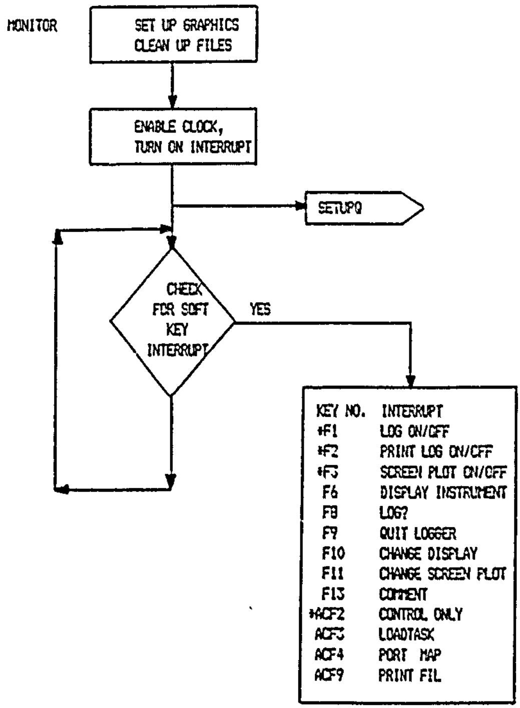


Figure A.1.5.0 -1. Simplified flow diagram of Data Logger program functions.

TRANSMISSOMETER DATA LOGGER
FLOWCHART



* FUNCTION KEYS ONLY CHANGE A PROGRAM SWITCH - THESE ROUTINE ARE NOT SHOWN IN FLOW DIAGRAM.
AC MEANS "ALT- CTRL" AND THE FUNCTION KEY
F11 IS "UP-ARROW
F13 IS "DOWN-ARROW"

Figure A.1.5.0 -1(continued). Simplified flow diagram of Data Logger program functions.

TRANSMISSOMETER DATA LOGGER
FLOWCHART

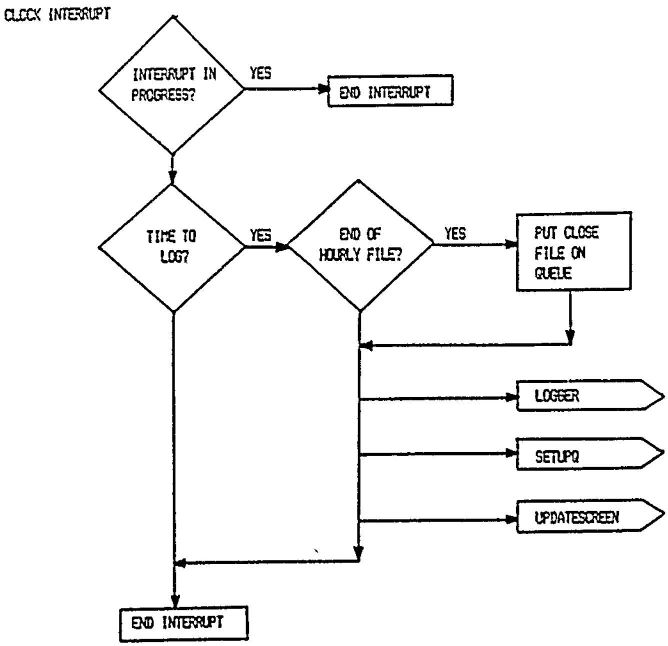


Figure A.1.5.0 -1(continued). Simplified flow diagram of Data Logger program functions.

TRANSMISSOMETER DATA LOGGER
FLOWCHART

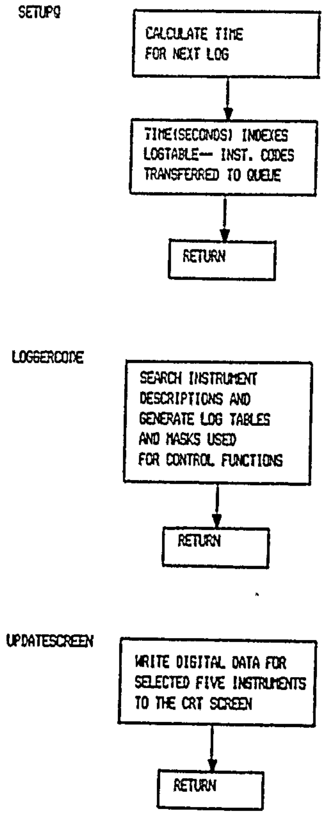


Figure A.1.5.0 -1(continued). Simplified flow diagram of Data Logger program functions.

TRANSMISSOMETER DATA LOGGER
FLOWCHART

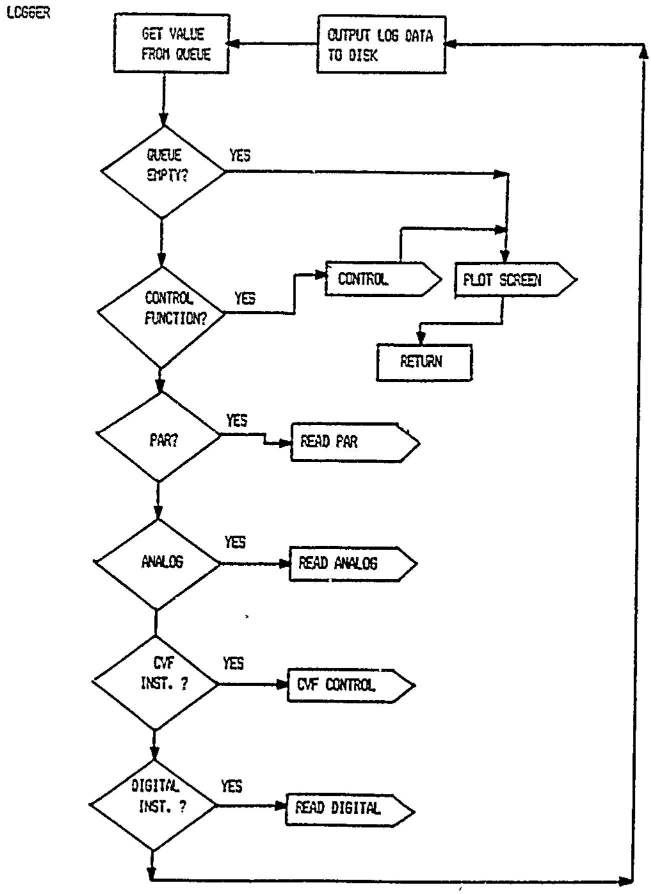


Figure A.1.5.0 -1(continued). Simplified flow diagram of Data Logger program functions.

TRANSMISSOMETER DATA LOGGER
FLOWCHART

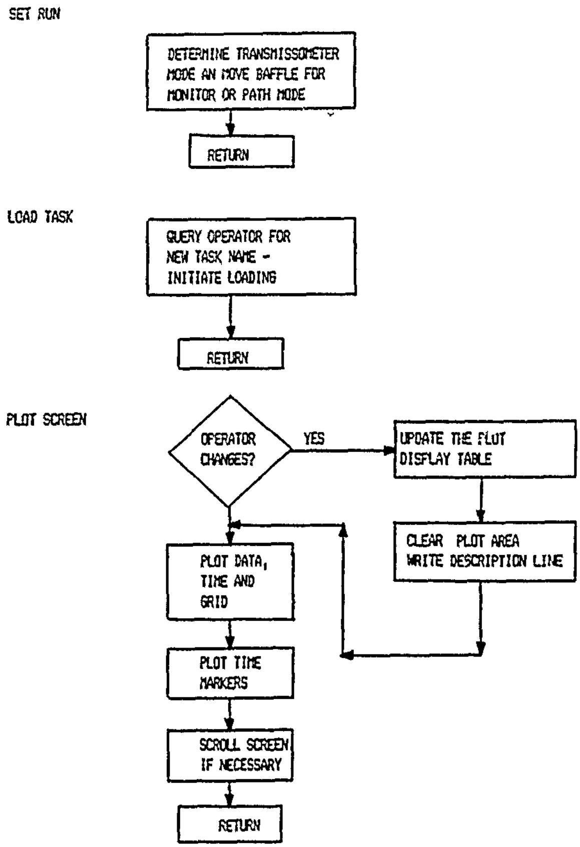


Figure A.1.5.0 -1(continued). Simplified flow diagram of Data Logger program functions.

TRANSMISSOMETER DATA LOGGER
FLOWCHART

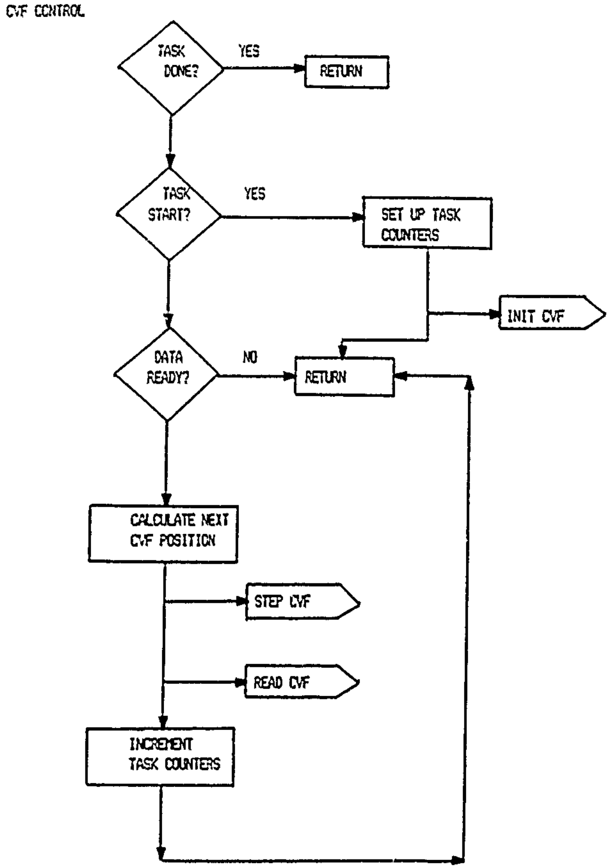


Figure A.1.5.0 -1(continued). Simplified flow diagram of Data Logger program functions.

TRANSMISSOMETER DATA LOGGER
FLOWCHART

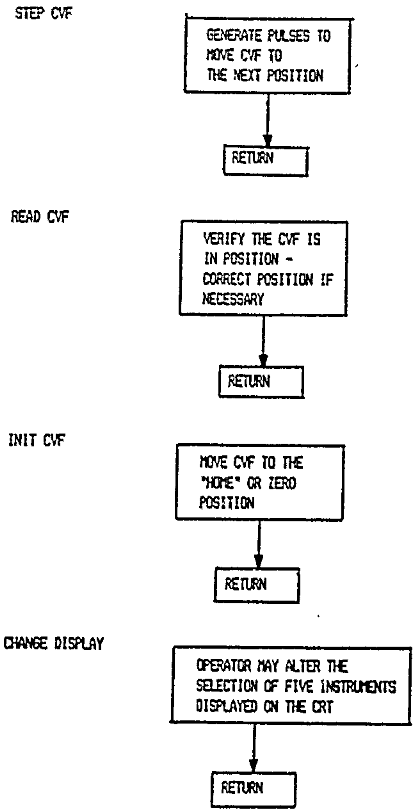
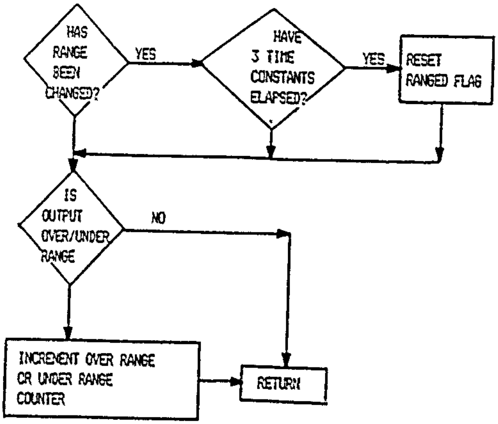


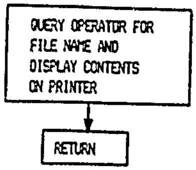
Figure A.1.5.0 -1(continued). Simplified flow diagram of Data Logger program functions.

TRANSMISSOMETER DATA LOGGER
FLOWCHART

PAR RANGE



PRINT FIL



PORT MAP

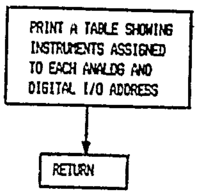


Figure A.1.5.0 -1(continued). Simplified flow diagram of Data Logger program functions.

TRANSMISSOMETER DATA LOGGER
FLOWCHART

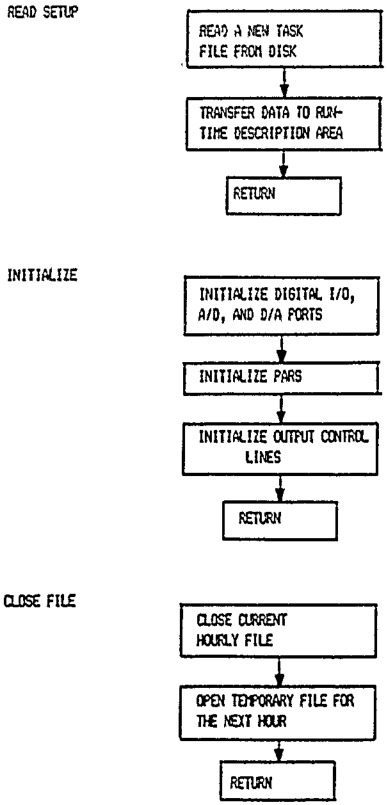


Figure A.1.5.0 -1(continued). Simplified flow diagram of Data Logger program functions.

TRANSMISSOMETER DATA LOGGER
FLOWCHART

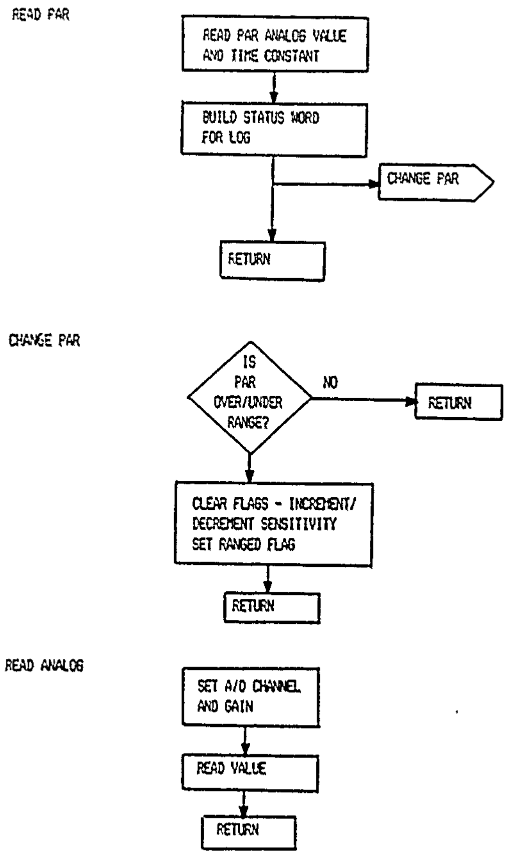


Figure A.1.5.0 -1(continued). Simplified flow diagram of Data Logger program functions.

TRANSMISSOMETER DATA LOGGER
FLOWCHART

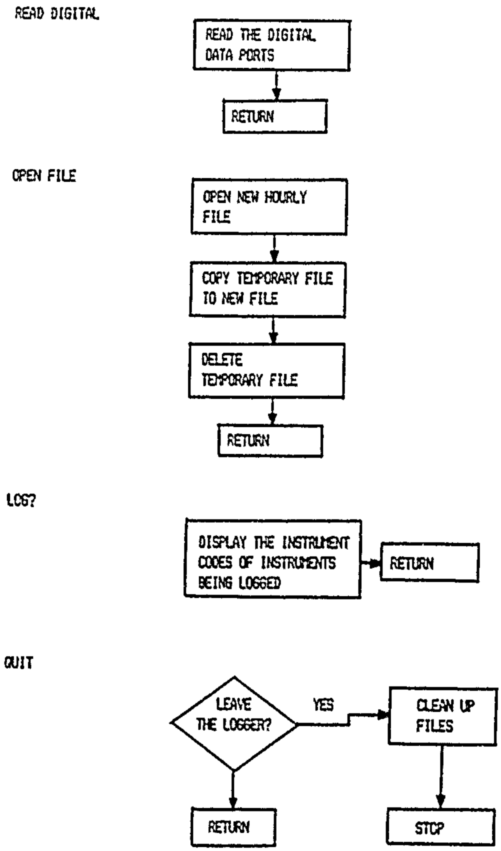


Figure A.1.5.0 -1(continued). Simplified flow diagram of Data Logger program functions.

A.1.6.0 Multichannel Transmissometer Data Processing

A.1.6.1 Initial Processing

Data logger data for the transmissometer is first processed with program "MCRED" to generate data which has been converted to engineering units (mv), time converted to minutes after midnight and coded wavelength changed to physical units. Each hour of processed data is placed in a separate subdirectory (named as r+month+day+hour, e.g. r071320). Data file names within each subdirectory are the same:

in000101.dat contains channel 1 data (0.53 μm)
in000201.dat contains channel 2 data (approx. 2.7 to 5.4 μm)
in000301.dat contains channel 3 data (approx. 7.3 to 13.2 μm).

Several hourly files (about 8) for each channel should be concatenated to make longer files which will shorten processing and editing of the data and plotting. These files are named raw+channel+month+day (e.g. for July 13):

raw10713.dat channel 1
raw20713.dat channel 2
raw30713.dat channel 3.

Each of these files should be edited to remove duplicated task header information which will occur at the beginning of an hour if the task continues from one hour to the next. This information can be obtained by inspecting the instrument files in the \log\data directory.

A.1.6.2 Clear Day Calibration

Choose the "clear day" data which will be used to determine the calibration. Make 3 copies of each of the edited data files for the calibration period with the following names:

ins1adat.dat channel 1 short path
inm1adat.dat channel 1 medium path
inl1adat.dat channel 1 long path

ins2adat.dat channel 2 short path
inm2adat.dat channel 2 medium path
inl2adat.dat channel 2 long path

ins3adat.dat channel 3 short path
inm3adat.dat channel 3 medium path
inl3adat.dat channel 3 long path

Edit each file and retain only the monitor and path data for the selected path.

A.1.6.3 Lowtran Model

Several lowtran (pctran) calculations are now made for the "clear day" conditions. The model is run as "met conditions", "horizontal path", with wave number limits and delta wavenumber as in the sample screens included. All runs use us standard atmosphere except as noted and require input of altitudes for ground level and first layer boundary, initial and final path altitudes, temperature and pressure and path length. Relative humidity should be entered as in the table below. "day" in %rh column means %rh at time data was acquired. File names below reflect the date July 13.

chan	path	%rh	.ltn file name	copy file7 to
1	monitor	0	t0i10713	t0i10713.sm
1	monitor	day	ti10713	ti10713.sm
1	short	day	ts10713	ts10713.sm
1	medium	day	tm10713	tm10713.sm
1	long	day	tl10713	tl10713.sm
2	monitor	0	t0i20713	t0i20713.sm
2	monitor	day	ti20713	ti20713.sm
2	short	day	ts20713	ts20713.sm
2	medium	day	tm20713	tm20713.sm
2	long	day	tl20713	tl20713.sm
3	monitor	0	toi30713	toi30713.sm
3	monitor	day	ti30713	ti30713.sm
3	short	day	ts30713	ts30713.sm
3	medium	day	tm30713	tm30713.sm
3	long	day	tl30713	tl30713.sm

Run the three programs "ch1cal", "ch2cal", "ch3cal". Each program will produce three files of calibration factors:

chan	path	calibration file
1	short	ch1sfact.dat
1	medium	ch1mfact.dat
1	long	ch1lfact.dat
2	short	ch2sfact.dat
2	medium	ch2mfact.dat
2	long	ch2lfact.dat
3	short	ch3sfact.dat
3	medium	ch3mfact.dat
3	long	ch3lfact.dat

data in these files is: a b c d
a = wavelength (μm)
b = path volts (at calibration time)
c = path transmission (at calibration time)
d = monitor volts (at calibration time)

Path volts and path transmission have been corrected to 0% relative humidity. Channel 2 data has also been corrected for co2 transmission.

A.1.6.4 Reducing data

Once the calibration factors have been found, the raw data for other days or times may be processed using programs "ch1proc", "ch2proc", and "ch3proc" to determine transmission. At present these programs produce the following files (month,day is July 14):

file	contents
vs0714.dat	short path - 0.53 μm transmission
vm0714.dat	medium path - 0.53 μm transmission
vl0714.dat	long path - 0.53 μm transmission
ms0714.dat	short path - 3-5 μm transmission
mm0714.dat	medium path - 3-5 μm transmission
ml0714.dat	long path - 3-5 μm transmission
fs0714.dat	short path - 8-12 μm transmission
fm0714.dat	medium path - 8-12 μm transmission
fl0714.dat	long path - 8-12 μm transmission

Files of transmission at selected wavelengths are:

file	contents
ms380714.dat	short path - 3.82 μm transmission
mm380714.dat	medium path - 3.82 μm transmission
ml380714.dat	long path - 3.82 μm transmission
fsco0714.dat	short path - 10.61 μm transmission
fmco0714.dat	medium path - 10.61 μm transmission
flco0714.dat	long path - 10.61 μm transmission
msbb0714.dat	short path - broadband 3-5 μm transmission
mmbb0714.dat	medium path - broadband 3-5 μm transmission
mlbb0714.dat	long path - broadband 3-5 μm transmission
fsbb0714.dat	short path - broadband 8-12 μm transmission
fmbb0714.dat	medium path - broadband 8-12 μm transmission
flbb0714.dat	long path - broadband 8-12 μm transmission

A.1.6.5 PC-TRAN Input Screens

The PC-TRAN input screens in the figures below may be used to aid in obtaining the proper model transmission data files as shown in section A.1.6.3. The screens are not intended to be inclusive but are primarily to demonstrate the proper horizontal path setup, MET condition entry and wavelength extent required by subsequent data reduction programs. Path lengths are those used during the FLAPIR program.

Figure A.1.6.5-1 is a complete set of input screens for modeling the 0.53 μm visible channel in monitor mode with no water vapor in the atmosphere and Figure A.1.6.5 -2 shows the change needed for the monitor scan with the proper percent relative humidity on the calibration day. Figures A.1.6.5-3 through -5 define the atmospheric path length for the short, medium and long paths respectively. Figures A.1.6.5-6 and -7 define the wavenumber extent for the 3-5 μm and 8-12 μm channels.

Model atmosphere	Met data (hor path only)
Type of atmospheric path	Horizontal path
Mode of execution	Transmittance
Executed with multiple scattering	No
Temperature & pressure altitude profile	
Water vapor altitude profile	
Ozone altitude profile	
Methane altitude profile	
Nitrous oxide altitude profile	
Carbon monoxide altitude profile	
Other gases altitude profile	
Radiosonde data are to be input	Yes
Output file options	Include atm profiles
Temp at boundary (.000 - t @ 1st level)	.000
Surface albedo (.000 - blackbody)	.000

Lowtran 7 card #1 screen

Aerosol model used	No aerosol attenuation
Seasonal modifications to aerosols	Determined by model
Upper atmosphere aerosols (30-100 km)	Background stratospheric
Air mass character for Navy Maritime aerosols	0
Use cloud/rain aerosol extensions	No clouds or rain
Use of Army (vsa) for aerosol extension	No
Surface range for boundary layer	.000
Wind speed for Navy Maritime aerosols	.000
24-hour average wind speed for Navy maritime	.000
Rain rate (mm/hr)	.000
Ground altitude above sea level (km)	.023

Lowtran 7 card #2 screen

Figure A.1.6.5-1. PC-TRAN input screens - monitor mode with no water vapor.

Boundary altitude (km) layer #1	2.600e-02
Pressure 1.022e+03	
Pressure option/units units are (mb)	
Temperature 1.500e+01	

Mol	Density option/units	Mol	Density option/units
H_2O	.000e+01 % Rel Humidity	CO_2	.000e+00 Use 1976 U. S. Standard
03	.000e+00 Use 1976 U. S. Standard		

Layer aerosol number density	.000e+00
Equivalent liquid to H_2O content (gm/m3)	.000e+00
Rain rate (mm/hr)	.00e+00
Aerosol model used	No aerosol attenuation
Use cloud/rain aerosol extensions	No clouds or rain
Seasonal modifications to aerosols	Determined by model
Change profile region	0

Lowtran7 card 2c1 - 2c3 screen

Number of atmospheric layers	1
Supply molecular densities by layer	no
Supply aerosol information by layer	no

Title:	
Initial altitude (km)	.026
Final altitude/tangent height (km)	.026
Initial zenith angle (degrees)	90.000
Path length (km)	.004
Earth center angle (degrees)	.000
Radius of earth (km) [.000 = default]	.000
0-short path; 1-long path	0
Initial frequency (wavenumber)	10000.000
Final frequency (wavenumber)	22000.000
Frequency increment (wavenumber)	20.000

Lowtran7 card #3&#4 screen

Figure A.1.6.5-1 (continued). PC TRAN input screens - monitor mode with no water vapor.

Boundary altitude (km) layer #1	2.600e-02
Pressure	1.022e+03
Pressure option/units	units are (mb)
Temperature	1.500e+01

Mol	Density option/units	Mol	Density option/units
H_2O	.000e+01 % Rel Humidity	CO_2	.000e+00 Use 1976 U. S. Standard
03	.000e+00 Use 1976 U. S. Standard		

Layer aerosol number density	.000e+00
Equivalent liquid to H_2O content (gm/m3)	.000e+00
Rain rate (mm/hr)	.00e+00
Aerosol model used	No aerosol attenuation
Use cloud/rain aerosol extensions	No clouds or rain
Seasonal modifications to aerosols	Determined by model
Change profile region	0

Lowtran7 card 2c1 - 2c3 screen

Figure A.1.6.5-2. Changes to PC-TRAN input screens - monitor mode, visible channel with water vapor content to present on the calibration day.

Initial altitude (km)	0.026
Final altitude/tangent height (km)	1.026
Initial zenith angle (degrees)	90.000
Path length (km)	.507
Earth center angle (degrees)	.000
Radius of earth (km) [.000 = default]	.000
0-short path; 1-long path	0
Initial frequency (wavenumber)	10000.000
Final frequency (wavenumber)	22000.000
Frequency increment (wavenumber)	20.000

Lowtran7 card #3&#4 screen

Figure A.1.6.5-3. Changes to PC-TRAN input screens - path mode, visible channel on the calibration day (short path - 507m).

Initial altitude (km)	.026
Final altitude/tangent height (km)	.026
Initial zenith angle (degrees)	90.000
Path length (km)	1.039
Earth center angle (degrees)	.000
Radius of earth (km) [.000 = default]	.000
0-short path; 1-long path	0
Initial frequency (wavenumber)	10000.000
Final frequency (wavenumber)	22000.000
Frequency increment (wavenumber)	20.000

Lowtran7 card #3&#4 screen

Figure A.1.6.5-4. Changes to PC-TRAN input screens - path mode, visible channel on the calibration day (medium path - 1039m)

Initial altitude (km)	.026
Final altitude/tangent height (km)	.026
Initial zenith angle (degrees)	90.000
Path length (km)	1.784
Earth center angle (degrees)	.000
Radius of earth (km) [.000 = default]	.000
0-short path; 1-long path	0
Initial frequency (wavenumber)	10000.000
Final frequency (wavenumber)	22000.000
Frequency increment (wavenumber)	20.000

Lowtran7 card #3&#4 screen

Figure A.1.6.5.-5. Changes to PC-TRAN input screens - path mode, visible channel on the calibration day (long path - 1794m).

Initial altitude (km)	.026
Final altitude/tangent height (km)	.026
Initial zenith angle (degrees)	90.000
Path length (km)	.004
Earth center angle (degrees)	.000
Radius of earth (km) [.000 = default]	.000
0-short path; 1-long path	0
Initial frequency (wavenumber)	1600.000
Final frequency (wavenumber)	4800.000
Frequency increment (wavenumber)	5.000

Lowtran7 card #3&#4 screen

Figure A.1.6.5-6. PC-TRAN input screen showing the wavenumber extent for channel 2 (3-5 μm).

Initial altitude (km)	.026
Final altitude/tangent height (km)	.026
Initial zenith angle (degrees)	90.000
Path length (km)	.004
Earth center angle (degrees)	.000
Radius of earth (km) [.000 = default]	.000
0-short path; 1-long path	0
Initial frequency (wavenumber)	400.000
Final frequency (wavenumber)	1700.000
Frequency increment (wavenumber)	5.000

Lowtran7 card #3&#4 screen

Figure A.1.6.5-7. PC-TRAN input screen showing wavenumber extent for channel 3 (8-12 μm).